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JOHN A. BRODIE, M. ENG. WH. SC., M. INST. C.E.

PRESIDENT, 1907—1908.

PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXXIV. 1907-1908

EDITED BY

THOMAS COLE

ASSOC. M. INST. C.E.

(*Secretary of the Association.*)

The Association is not as a body responsible for the statements and opinions advanced herein.

London
E. & F. N. SPON, LIMITED, 57 HAYMARKET
New York
SPON & CHAMBERLAIN, 123 LIBERTY STREET
1908

M. Eng., Wh. Sc., M. Inst. C.E.

1907–1908

Institution of municipal & county engineers, Lond.

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LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
GREAT WINDMILL STREET, W., AND DUKE STREET, STAMFORD STREET, S.E.

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John A. Brodie, M. Eng., Wh. Sc., M.Inst. C.E., *President.*

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PAST PRESIDENTS.

1873–4 / 1874–5	LEWIS ANGELL, M. Inst. C.E.
1875–6.	*J. G. LYNDE, M. Inst. C.E.
1876–7.	JAMES LEMON, M. Inst. C.E.
1877–8.	*F. ASHMEAD, M. Inst. C.E.
1878–9.	G. F. DEACON, LL.D., M. Inst. C.E.
1879–80.	*E. PRITCHARD, M. Inst. C.E.
1880–1.	*A. W. MORANT, M. Inst. C.E.
1881–2.	*W. S. TILL, M. Inst. C.E.
1882–3.	C. JONES, M. Inst. C.E.
1883–4.	W. H. WHITE, M. Inst. C.E.
1884–5.	*W. G. LAWS, M. Inst. C.E.
1885–6.	*R. VAWSER, M. Inst. C.E.
1886–7.	J. LOBLEY, M. Inst. C.E.
1887–8.	*J. GORDON, M. Inst. C.E.
1888–9.	E. B. ELLICE-CLARK, M. Inst. C.E.
1889–90 / 1890–91	H. P. BOULNOIS, M. Inst. C.E.
1891–2.	T. DE C. MEADE, M. Inst. C.E.
1892–3.	J. CARTWRIGHT, M. Inst. C.E.
1893–4.	J. T. EAYRS, M. Inst. C.E.
1894–5.	A. M. FOWLER, M. Inst. C.E.
1895–6.	*E. R. S. ESCOTT, M. Inst. C.E.
1896–7.	*F. J. C. MAY, M. Inst. C.E.
1897–8.	Sir ALEX. R. BINNIE, M. Inst. C.E.
1898–9.	O. C. ROBSON, M. Inst. C.E.
1899–1900.	W. HARPUR, M. Inst. C.E.
1900–01.	*C. H. LOWE, M. Inst. C.E.
1901–02.	E. GEORGE MAWBEY, M. Inst. C.E.
1902–03.	T. H. YABBICOM, M. Inst. C.E.
1903–04.	W. WEAVER, M. Inst. C.E.
1904–05.	A. T. DAVIS, M. Inst. C.E.
1905–06.	A. E. COLLINS, M. Inst. C.E.
1906–07.	J. PATTEN BARBER, M. Inst. C.E.
1907–08.	J. A. BRODIE, M. Eng., Wh. Sc., M. Inst. C.E.

* Deceased.

LIST OF MEMBERS.

IT IS PARTICULARLY REQUESTED THAT EVERY CHANGE OF ADDRESS MAY BE COMMUNICATED WITHOUT DELAY TO THE SECRETARY.

* *Those Members against whose names a star is placed have passed the examination and hold the Testamur of the Association.*

R *signifies re-election under By-law 5a.* G *elected as Graduate.* A *elected as Associate.* AM *elected as Associate Member.* TA *transferred to Associate.* TAM *transferred to Associate Member.* T *transferred to Member.*

P *signifies recipient of Association's £10 premium.*

P " " " £5 *premium.*

p " " " £3 *premium.*

HONORARY MEMBERS.

Date of Election and Transfer.		
1898 Dec. 17	BICKNELL, R. H., M. Inst. C.E.	Local Government Board, Whitehall, S.W.
1888 Mar. 3	CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
1904 Feb. 27	COWAN, P. C., M.Inst.C.E.	Chief Engineering Inspector, Local Government Board, Ireland.
1905 Sept. 23	HAWKSLEY, CHARLES, M. Inst. C.E.	30 Great George Street, S.W.
1892 Apr. 23	PUTZEYS, E.	Ingénieur en chef, Directeur de la Ville de Bruxelles.
1890 Sept. 13	ROBINSON, PROFESSOR HY., M. Inst. C.E.	Parliament Mansions, Westminster, S.W.
1874 June 1	TULLOCH, MAJOR H., C.B., R.E.	28 Victoria Street, S.W.
1904 Jan. 23	WILLCOCKS, G. W., M. Inst. C.E.	Chief Engineering Inspector, Local Government Board, Whitehall, S.W.

MEMBERS.

1893 Oct. 21	ABRAHAMS, C. V.	City Surveyor, Kingston, Jamaica.
1894 June 21 R1902 Mar. 22	ABURROW, C., M. Inst. C.E...	515 Consolidated Buildings, Johannesburg, S.A.
1903 May 16	ADAMS, A. E...	Borough Engineer, Chippenham, Wilts.
*p*1896 Jan. 18	AITKEN, T., M. Inst. C.E. ..	County Surveyor, Cupar, Fife.
1897 Jan. 16	ALLEN, A. T...	Surveyor to the Urban District Council, Portslade-by-Sea, Sussex.
1873 May 2 R1884 Jan. 26	*ALLEN, T. T...	Broad Street, Stratford-on-Avon.
1897 June 19	ALVES, G.	Surveyor to the Urban District Council, Glastonbury.

Date of Election and Transfer.		
1890 June 26	Anderson, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
1900 Dec. 15	Anderson, W. V., Assoc. M. Inst. C.E.	City Surveyor, Winchester.
1906 Apr. 28	Andrew, J.	Burgh Surveyor, Dunoon, N.B.
G1898 June 30 T1899 Oct. 21	*Andrews, S. P.	Borough Surveyor, Faversham.
G1894 Oct. 20 T1899 Oct. 21	*Angel, R. J., M. Inst. C.E. ..	Borough Surveyor, Bermondsey, S.E.
1894 May 19	*Angell, J. A., A.M.Inst.C.E.	Surveyor to the Urban District Council, Beckenham, S.E.
1873 Feb. 15	ANGELL, LEWIS, M. Inst. C.E. (*Past President, and Hon. Treasurer. Member of Council.*)	"Calside," Carlisle Road, Eastbourne.
1899 June 29	*Anstee, J.	Surveyor to the Rural District Council, Guildford.
1880 May 27 R1899 Feb. 25	Armistead, R., Assoc. M. Inst. C.E.	8 Charles Street, Bradford.
1900 June 16	Asquith, A.	Surveyor to the Urban District Council, Holyhead.
1890 June 26	Atkinson, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
1904 Aug. 4	Atkinson, T. R.	County Surveyor, Earlston, Berwickshire, N.B.
1897 Feb. 13 R1905 Sept. 23	Baff, C. J.	Council Chambers, Gosforth, Newcastle-on-Tyne.
1904 Jan. 23	Baines, C. O.	Surveyor to the Urban District Council, Paignton.
1900 Feb. 10	Bains, G. S. L.	Surveyor to the Urban District Council, Saltburn-by-the-Sea.
1884 May 29	Baker, F.	Borough Surveyor, Middlesbrough, Yorks.
1891 Aug. 1 R1903 Feb. 21	Baker, J., A.M. Inst. C.E. ..	75 High Street, Slough.
1896 June 25	Baldwin, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.
G1891 Aug. 1 T1896 Feb. 22	*Ball, B., A.M. Inst. C.E. ..	Borough Surveyor, Nelson, Lancs.
G1887 Sept. 17 T1898 Feb. 19	*Ball, G., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Bexhill.
1879 Oct. 23	Banks, W., A.M. Inst. C.E.	City Surveyor, Rochester.
1905 Apr. 29	Barber, E. H., A.M.Inst.C.E.	Town Surveyor, Goole.
1887 Mar. 12	BARBER, J. PATTEN, M. Inst. C.E. (*Past President. Member of Council.*)	Borough Engineer, Islington, N.
G1901 Aug. 24 T1906 Apr. 28	*Barker, H. W.	Surveyor to the Urban District Council, Walmer.
G1888 Sept. 15 T1892 July 11	*Barnes, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
1897 Jan. 16	Barrett, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Staines.
1899 Jan. 21	Barrs, J. D.	Surveyor to the Urban District Council, Bromyard.

Date of Election and Transfer.		
G1903 Jan. 17 / T1905 May 27	*Bate, E. M.	Surveyor to the Urban District Council, Frinton-on-Sea.
1896 Oct. 24 / R1904 May 28	Baylis, T. P., Assoc. M. Inst. C.E.	Surveyor, Droitwich.
G1901 June 8 / T1903 July 25	*Beacham, W. E.	Town Surveyor, Leek.
1903 May 16	Bean, J. A.	County Surveyor, Northumberland. Moot Hall, Newcastle.
1894 Jan. 13	Beaumont, A.	County Surveyor, Yorks, East Riding. County Hall, Beverley.
1897 Mar. 13	Beaumont, G. E.	Surveyor to the Rural District Coun., Wortley. "Holme Lea," Greenoside, near Sheffield.
1897 Mar. 13	Beaumont, T. C.	Surveyor to the Rural District Council, Driffield.
1892 Jan. 16	Bell, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
1897 Jan. 16	Bell, G. J., M.Inst.C.E. ..	County Surveyor, Cumberland. Carlisle.
A1902 Jan. 25 / T1906 Dec. 15	*Bell, L. M., M.Inst.C.E. ..	Municipal Engineer, Penang, S.S.
1906 Apr. 28	Bell, T. H.	Surveyor to the Urban District Council, Ramsbottom.
1895 Jan. 19	Bellingham, A. W. H., M. Inst. C.E.	Engineer-in-Chief, British Municip., Tientsin, North China.
1896 Jan. 18	Bennett, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
1886 Dec. 18 / R1902 Nov. 8	Bennett, W. B. G., M. Inst. C.E.	Midland Bank Chambers, Southampton.
G1898 Dec. 17 / T1900 July 19	*Bennetts, J. P.	Surveyor to the Urban District Council, Harrow.
1886 Oct. 16 / R1896 Jan. 18	Berrington, R. E. W., M. Inst. C.E.	Graisley, Wolverhampton.
1892 Mar. 11 / R1899 May 6	Beswick, W. H., Assoc. M. Inst. C.E.	214 Astley Street, Dukinfield, Cheshire.
1891 June 6	Bettany, F.	Borough Engineer, Burslem.
1902 Mar. 22	Bibbey, T.	Cheadle, Staffs.
1890 Mar. 29	BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	9 Gt. George Street, Westminster, S.W.
1896 Nov. 28 / R1908 Apl. 25	Bird, W. F.	The Island, Midsomer Norton.
1897 Jan. 16	Birks, E.	Highway Surveyor to Rural District Council, Uxbridge.
1901 Feb. 16	Blackburn, J.	Surveyor to the Urban District Council, Soothill Upper.
P1873 May 2	Blackshaw, W., Assoc. M. Inst. C.E.	Borough Surveyor, Stafford.
1904 Aug. 5	Blackwood, R.	Burgh Surveyor, Kilmarnock, N.B.
1886 June 12	Blair, W. N., M. Inst. C.E. (*Vice-President.*)	Borough Surveyor, St. Pancras.
1903 Oct. 17	Bland, J. D.	Surveyor to the Urban District Council, Chesterton.
1907 Apr. 27	Blaney, C.	Borough Surveyor, Newry, Ireland.
1900 Mar. 10	Blood, A. T.	Surveyor to the Urban District Council, Hitchin.
1907 May 25	Boddie, C. L., A.M.Inst.C.E.	County Surveyor, Londonderry.
1902 Nov. 8	*Borg, E. A.	Borough Surveyor, Margate.

Date of Election and Transfer.		
1895 Jan. 19 R1903 Feb. 21	BOTTERILL, C., A.M.Inst.C.E.	583 Fulham Road, Walham Green, S.W.
1904 Feb. 27	BOTTOMLEY, H.	Surveyor to the Urban District Council, Bingley.
1877 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	Local Government Board, Whitehall, S.W.
1903 Dec. 12	BOURNE, J.	Surveyor to the Urban District Council, Rawmarsh.
1898 Mar. 19 R1903 Feb. 21	BOWEN, H. W.	County Surveyor, West Sussex County Council, Horsham.
1904 Aug. 12	BOWIE, J. McL.	Burgh Surveyor, Maxwelltown, Dumfries, N.B.
1898 Oct. 15	BOYLE, J. C., A. M. Inst. C.E.	City Surveyor, Armagh.
1903 May 16	BRADLEY, A.W., A.M.Inst.C.E.	Borough Engineer, Bury, Lancs.
G1889 May 18 T1893 Apr. 22	*BRADLEY, J. W., M. Inst. C.E.	City Engineer, Westminster, S.W.
1897 Jan. 16	BRADLEY, W. L.	Surveyor to the Urban District Council. Tonbridge.
G1894 Jan. 13 T1896 Oct. 24	*BRADSHAW, F. E. G.	Borough Surveyor, Tamworth.
1878 May 2	BRESSEY, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
1891 Aug. 1	BRETT, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	BRETTELL, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	BRIDGES, O. A.	Surveyor to the Urban District Council, Bognor.
1891 Mar. 21	BRIERLEY, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
1901 Dec. 7	BRODIE, J. A., M. Eng., Wh. Sc., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Liverpool.
1889 Apr. 13	BRODIE, J. S., M. Inst. C.E...	Borough Engineer, Blackpool.
1894 Oct. 20	BROOKE, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
1884 July 10	BROWN, A., M. Inst. C.E. ..	Borough Engineer, Nottingham.
1898 Jan. 15	BROWN, C., A. M. Inst. C.E...	Borough Engineer, Chelmsford.
1904 Aug. 25	BROWN, CHAS.	Burgh Surveyor, Hawick, N.B.
1905 Jan. 28	BROWN, F.	Town Engineer, Kroonstad, O.R.C., South Africa.
1908 Jan. 18	BROWN, H. E.	Surveyor to the Urban District Council, Altrincham.
1905 Sep. 23	BROWN, H. H. Lane, M. Inst. C.E.	Supervising Engineer, Lucknow, United Provinces, India.
1881 June 18 R1904 Jan. 23	BROWN, J. W., M. Inst. C.E.	Church Square, West Hartlepool.
G1894 July 7 T1898 Sept. 3	*BROWN, R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Southall Norwood.
1889 Feb. 9 R1898 Jan. 15	*BROWN, R. R.	Electrical Engineer to the Urban District Council Bridlington.

Date of Election and Transfer.		
1893 Mar. 4	*BROWNRIDGE, C., M. Inst.C.E. (*Member of Council.*)	Borough Engineer, Birkenhead. *Hon. Secretary*, Lancashire and Cheshire District.
1904 Aug. 9	BRUCE, J. S.	Burgh Surveyor, Kirriemuir, N.B.
1901 Feb. 16	BRYCE, J., A.M. Inst. C.E. (*Member of Council*).	Burgh Surveyor, Partick, N.B. *Hon. Sec.*, Scottish District.
G1889 Feb. 9 T1902 Mar. 22	*BRYNING, W. G.	County Surveyor, Northallerton, Yorks.
1873 May 2	BUCKHAM, E., M. Inst. C.E.	Borough Surveyor, Ipswich.
1897 July 8 R1902 Mar. 22	BUCKLEY, M. J., Assoc. M. Inst. C.E.	26 Bessborough Terrace, N.C.R., Dublin.
1897 Feb. 13	BULL, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
1895 Feb. 16	BUNTING, T. F.	Borough Surveyor, Maidstone.
1895 Jan. 19	BURDEN. A. M., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny.
1892 Sept. 24	BURGESS, S. E., M. Inst. C.E.	Borough Engineer, South Shields.
1900 Apr. 21	BURKITT, J. P., A.M.Inst.C.E.	County Surveyor, Enniskillen.
1905 Mar. 3	BURN, W., A. M. Inst. C.E...	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
1904 Aug. 6	BURNS, D.	Burgh Surveyor, Pollokshaws, N.B.
1890 June 7	BURSLAM, R.	Borough Surveyor, Congleton.
G1895 Jan. 19 T1902 Jan. 25	*BURTON, A., A.M. Inst. C.E.	Borough Engineer, Stoke-on-Trent.
1897 Jan. 16	BUSBRIDGE, T. A...	Surveyor to the Rural District Council, Spilsby.
G1899 June 29 TA1902 Jan. 25 T1904 Feb. 27	*BUSH, W. E., A. M. Inst. C.E.	City Engineer, Auckland, New Zealand.
1890 Sept. 13	BUTLER, W.	Surveyor to the Urban District Council, Fareham.
1899 June 29	BUTTERWORTH, A. S., Assoc. M. Inst. C. E.	Municipal Engineer, Port Elizabeth, S. Africa.
G1905 Dec. 9 T1907 Apr. 27	*BUTTERWORTH, G. L.	Surveyor to the Rural District Council, Isle of Thanet.
1894 Apr. 6	CAINE, T., Assoc.M.Inst. C.E.	City Engineer, Worcester.
1891 Dec. 12 R1903 Jan. 17	CAIRNCROSS, T. W., Assoc. M. Inst. C.E.	Bd. of Exors. Buildings, c/o Wale, Adderley Street, Cape Town, S.A.
1903 Jan. 17	CALDER, W., A. M. Inst. C.E.	City Engineer, Prahran, Victoria.
1891 Oct. 17	CAMPBELL, A. H., M. Inst. C.E.	Engineer and Surveyor, Town Hall, East Ham, E.
1887 Mar. 12	CAMPBELL, K. F., M. Inst. C.E.	Borough Engineer, Huddersfield.
1888 May 12	CAPON, E. R.	Surveyor to the Urban District Council, Epsom.
1890 Oct. 18 R1899 Jan. 21	CARD, H...	North Street, Lewes.
1903 Feb. 21	CARTER, A. H.	Surveyor to the Urban District Council, Litherland, Liverpool.

Date of Election and Transfer.		
1901 June 27	Carter, G. E.	Surveyor to the Rural District Council, Winchester.
1897 June 19	Carter, G. F.	Surveyor to the Urban District Council, Mexborough.
G1892 July 11 TA1901 Dec. 7 T1904 Jan. 23	*Carter, G. F., M.Inst.C.E...	Borough Engineer, Croydon.
1898 Dec. 17	Cartwright, A. S.	Surveyor to the Urban District Council, Wilmslow, Cheshire.
1873 May 2	CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	21 Parsons Lane, Bury.
1904 June 26	Carver, W.	Surveyor to the Rural District Council, Melford. 3 Melford Road, Sudbury, Suffolk.
1895 Mar. 16	Cass, R. W.	Surveyor to the Urban District Council, Farnham, Surrey.
1895 Mar. 16 R1899 Feb. 25	Catt, A. J.	"Laurel Dene," Kingston-by-Sea, near Brighton.
1896 Mar. 21	Chadwick, J...	Surveyor to the Urban District Council, Fenny Stratford.
1903 Jan. 17	Chambers, S. H. (*Member of Council.*)	Surveyor to the Urban District Council, Hampton. *Hon. Secretary*, Home District.
1901 Dec. 7	Chancellor, W. B.	City Surveyor, Lichfield.
1897 Jan. 16	Chapman, C. R. W.	Surveyor to the Urban District Council, Wembley.
1893 Mar. 4 R1899 May 6	Charles, T.	Bessborough Road, Harrow.
1884 Dec. 20	Chart, R. M.	Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1900 Feb. 10	Chowins, W. H.	Surveyor to the Urban District Council, Burnham, Somerset.
1906 Mar. 3	Christie, S. L.	Burgh Surveyor, Montrose, N.B.
1884 Oct. 9 R1907 June 20	Clark, J., A.M. Inst. C.E...	Surveyor, Sleaford.
1898 Sept. 3	Clark, E. O'N.	County Surveyor, Leitrim.
1908 Jan. 18	Clark, W. G. J.	Surveyor to the Urban District Council, Wigston Magna, Leicester.
A1902 May 10 T1904 Apr. 30	Clarke, G. E., A.M.Inst.C.E.	Borough Surveyor, Boston, Lincolnshire.
1899 Oct. 21	Clarke, H. A.	Surveyor to the Urban District Council, Briton Ferry.
1898 Oct. 15	Clarry, W. H., A. M. Inst. C.E.	Borough Surveyor, Sutton Coldfield.
1886 Dec. 18	Clarson, H. J.	Surveyor to the Rural District Council, Tamworth.
1901 May 11	Clayton, F. T.	Borough Engineer, Reigate.
1893 July 31	Clough, W.	Surveyor to the Urban District Council, Audenshaw.
1899 Oct. 21	Clucas, R. H.	Borough Surveyor, Kingston-on-Thames.
G1894 July 7 T1896 Oct. 24	*Coales, H. F.	Surveyor to the Urban District Council, Sunbury-on-Thames.
G1886 Oct. 16 T1888 July 12	*Coales, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
1882 Sept. 30	Cockrill, J. W., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Great Yarmouth.

Date of Election and Transfer.		
1893 June 24	COCKRILL, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade, Beds.
1904 June 26	COLEBY, H. J.	Surveyor to the Rural District Council, Atherstone, Warwickshire.
1892 Sept. 24	COLLEN, W. M.A., M.Inst.C.E.	County Surveyor, Dublin.
1888 May 12	COLLINS, A. E., M.Inst.C.E. (*Past President. Member of Council.*)	City Engineer, Norwich.
1900 Oct. 15 R1901 June 27	COLLINS, G. M., Assoc.M.Inst. C.E.	17 Saville Road, Blackpool.
1896 Jan. 18	COLLINS, R.	Surveyor to the Urban District Council, Enfield, N.
1905 Apr. 29	COLLINS, W. A.	Surveyor to the Rural District Council, Bridgwater.
1886 May 1 R1897 Feb. 13	COMBER, P. F., M. Inst. C.E.	19 Lower Leeson Street, Dublin.
G1897 July 31 T1900 Dec. 15	*COOK, F. C.	Surveyor to the Urban District Council, Nuneaton.
1893 Apr. 22	COOK, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
G1888 July 12 T1890 Mar. 29 R1908 Jan. 18	*COOK, J., Assoc. M. Inst. C.E.	The Cottage, Gateacre Brow, Gateacre, near Liverpool.
G1888 July 12 T1890 Mar. 29	*COOPER, C. H., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Wimbledon. 15 Dora Road, Wimbledon Park, S.W.
1898 Sept. 3	COOPER, E. C.	Surveyor to the Urban District Council, Shanklin, Isle of Wight.
1894 Oct. 20	COOPER, F. A., C.M.G., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
1887 Sept. 17	COOPER, W. W.	Surveyor to the Urban District Council, Slough.
1893 Apr. 22 R1902 Nov. 8	COPLEY, C. T., A.M.Inst.C.E.	252 Barkerhouse Road, Nelson, Lancashire.
1896 Jan. 18	CORDON, R. C.	Surveyor to the Rural District Council, Belper. "Belmont," Duffield, near Derby.
G1896 May 29 T1897 June 19	*CORRIE, H. W.	Surveyor to the Urban District Council, Lower Bebington, Cheshire.
1894 June 21 R1903 Jan. 17	COTTERELL, A. P. I., M.Inst. C.E.	28 Baldwin Street, Bristol; and 17 Victoria Street, S.W.
1906 Mar. 3	COTTLE, F.	Borough Engineer, Douglas, Isle of Man.
1891 June 25 R1897 July 31	COVERLEY, J. S.	Surveyor, Penmaenmawr.
1898 May 21	COX, J.	Surveyor to the Urban District Council, Margam, Port Talbot.
P1880 Feb. 7	COX, J. H., M. Inst. C.E. ..	City Surveyor, Bradford.
1900 Mar. 10	CRABTREE, W. R., M.Sc.(Vict.), A. M. Inst. C.E.	Surveyor to the Rural District Council, Doncaster.
P1881 May 6	CREER, A., Assoc. M. Inst.C.E.	Engineer to Ouse and Foss Navigations. Yewhurst, Bickley, Kent.

Date of Election and Transfer.		
1900 July 19	Cross, A. W., A. M. Inst. C.E.	Surveyor to the Urban District Council, King's Norton.
1889 Dec. 14	*Crowther, J. A., Assoc. M. Inst. C.E.	Borough Engineer, Southampton.
G1907 May 25 T1908 July 18	*Croxford, J. W...	Surveyor to the Urban District Council, Brentford.
G1900 Jan. 19 T1903 May 16	*Crump, E. H., A. M. Inst. C.E.	Surveyor to the Urban District Council, Hinckley.
G1898 June 30 T1904 Apr. 30	*Cudbird, T. O.	Borough Surveyor, Beccles.
1900 June 16	Cumming, W.	Highway Surveyor to the Rural District Council, Lanchester, co. Durham.
1889 Dec. 14	Currall, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
1896 Apr. 25	Curry, W. F.	P.W.D., Pretoria, South Africa.
1893 Mar. 4 R1899 Feb. 25	Curry, W. T., A. M. Inst. C.E.	Minas de Rio Tinto, Provincia de Huelva, Spain.
1897 Feb. 13	Cutler, H. A., M. Inst. C.E.	City Surveyor, Belfast.
1893 June 24	*Dalton, J. P. .. .. .. (*Member of Council.*)	Surveyor to the Urban District Council, Ryton-on-Tyne. *Hon. Secretary*, Northern District.
1899 Jan. 21	Davidson, J. F.	Surveyor to the Urban District Council, Willington Quay.
1900 Oct. 15	Davies, W. J.	Surveyor to the Urban Dristrict Council, Nantyglo and Blaina. Council Offices, Blaina.
1880 Apr. 10	DAVIS, A. T., M. Inst. C.E. (*Past President.*) (*Member of Council.*)	County Surveyor, Salop. Shrewsbury.
1900 Oct. 15	*Dawson, C. F.	Surveyor to the Urban District Council, Barking.
1884 Apr. 19 R1902 Nov. 8	Dawson, C. J.	Wykeham House, Barking.
1896 July 25	Dawson, N. H.	Borough Surveyor, Banbury.
1898 Jan. 15	Day, C.	Borough Surveyor, Chatham.
1873 Dec. 9	DEACON, G. F., LL.D. (Glasgow), M. Inst. C.E. (*Past President.*)	16 Great George Street, Westminster, S.W.
1898 Jan. 15	Deane, J. W...	Surveyor to the Urban District Council, Smallthorne.
1892 Mar. 11	*Dearden, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
1904 July 14	Delany, J. F.	City Engineer, Cork.
P1890 Feb. 1	Dennis, N. F., A.M.Inst.C.E.	Borough Engineer, West Hartlepool.
1896 July 25	Dewhirst, J...	Surveyor to the Rural District Council, Chelmsford.
G1898 Oct. 15 T1899 June 10	*Dickinson, A. J.	Surveyor to the Urban District Council, Redditch.
1895 June 27	Dickinson, R.	Surveyor to the Urban District Council, Berwick-on-Tweed.

Date of Election and Transfer.		
1900 Feb. 10	DIGGLE, JAMES	Surveyor to the Urban District Council, Matlock.
1881 Dec. 10	DIGGLE, J., A.M. Inst. C.E.	Water Engineer, Heywood.
1889 Sept. 21	DIGGLE, WM.	Surveyor to the Rural District Council, Runcorn. Frodsham, Chester.
1877 Oct. 20	DITCHAM, H.	Borough Surveyor, Harwich.
1897 Apr. 10	DIVER, D. J.	Surveyor to the Urban District Council, Marple, near Stockport.
1897 Jan. 16 / R1903 Jan. 17	DIXON, F. J., A.M. Inst. C.E.	Town Hall Chambers, Ashton-under-Lyne.
G1891 Aug. 1 / T1896 Oct. 24	*DIXON, J. R., M. Inst. C.E.	Borough Engineer, Town Hall, Woolwich.
1887 June 18	DIXON, R., Assoc.M.Inst.C.E.	Borough Surveyor, Stratford-on-Avon.
1889 July 4	DODD, P., Assoc. M. Inst.C.E.	Borough Surveyor, Wandsworth, S.W., 27 Carlton Road, Putney, S.W.
1897 Jan. 16	*DODGEON, A., A.M. Inst. C.E.	Surveyor to the Urban District Council, Clayton-le-Moors.
1888 May 12	DORMAN, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh. *Hon. Secretary*, Irish District.
1898 June 30	DORMER, P. C.	Surveyor to the Urban District Council, Chesham, Bucks.
G1903 June 25 / T1904 Sept. 17	*DOUGLAS, S.	Surveyor to the Urban District Council, Kenilworth.
1906 Jan. 20	DOUGLASS, W. L., M.Inst.C.E.	District Engineer, Middle Ward, Lanark County. District Offices, Hamilton, N.B.
1899 Oct. 21	DRYLAND, A., A. M.Inst. C.E.	County Surveyor, Wiltshire.
1891 Dec. 12	DUFFIN, W. E. L., M. Inst. C.E.I.	County Surveyor, Waterford, Ireland.
1900 Dec. 15 / R1901 June 8	DUNCH, T. H.	27 Clement's Lane, Lombard Street, E.C.
1898 May 21	DUNN, J...	Surveyor to the Rural District Council, Chesterton. Brunswick House, Cambridge.
1873 Feb. 15	DUNSCOMBE, C., M.A., M. Inst. C.E.	92 Victoria Street, Westminster, S.W.
G1891 Jan. 21 / T1892 Sept. 24	*DYACK, W., M. Inst. C.E. ..	Burgh Surveyor, Aberdeen.
1882 June 29	DYER, S...	Engineer to the Rural District Council, Bridlington, 29 Quay Road, Bridlington.
1879 May 1	EARNSHAW, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
1904 Aug. 3	EASTON, W. C., B. Sc., M. Inst. C.E.	Glasgow Main Drainage Works, Partick, N.B.
1883 Aug. 4	EATON-SHORE, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
1877 Nov. 18	EAYRS, J. T., M. Inst. C.E. (*Past President.*)	89 Corporation Street, Birmingham.
1890 May 3	EBBETTS, D. J.	Surveyor to the Urban District Council, Acton.
1890 Feb. 1	EDDOWES, W. C.	Borough Surveyor, Shrewsbury.

Date of Election and Transfer.		
1891 Jan. 21 R1896 Jan. 18	*EDGE, F. J., M. Inst. C.E. ..	22 Collingwood Buildings, Newcastle-on-Tyne.
1891 Sept. 12	EDMONDSON, S.	Surveyor to the Rural District Council, Burnley.
1904 Jan. 23	EDWARDS, H. C. J., Assoc. M. Inst. C.E.	Borough Engineer, Lambeth.
1907 Nov. 2	ELCE, W. H., A. M. Inst. C.E.	Borough Engineer, Bacup.
1897 July 31	*ELFORD, E. J.	Borough Surveyor, Southend-on-Sea.
1873 Feb. 15	ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	13 Charles Street, St. James's, London, S.W.
1900 Apr. 21	ELLIOTT, F. T.	Surveyor to the Urban District Council, Wrotham, Kent.
1907 May 25	ENGLAND, J.	Borough Engineer, Wrexham.
1895 July 27	ENTWISLE, H.	Surveyor to the Urban District Council, Swinton, near Manchester.
1897 Jan. 16	EVANS, E., A. M. Inst. C.E.	County Surveyor, Carnarvonshire.
1895 Jan. 19	EVANS, E. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, S. Wales.
1896 May 29	EVANS, J. P.	Surveyor to the Rural District Council, Wrexham.
1903 Oct. 17	EVANS, S.	County Surveyor, Mold, Flintshire.
1890 June 7	FAIRLEY, W., A.M. Inst. C.E.	Richmond Main Sewerage Board, Kew Gardens, S.W., and 69 Victoria Street, S.W.
G1898 June 30 T1899 Feb. 25	*FARNHAM, W. A.	Surveyor to the Urban District Council, Foots Cray. Sidcup.
1893 July 31	FARRINGTON, T. B., A. M. Inst. C.E.	Surveyor to the Rural District Council, Conway. Trinity Square, Llandudno.
1896 Jan. 18	FARRINGTON, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Woodford Green, Essex.
1900 Dec. 15	*FELLOWS, T. E.	Surveyor to the Urban District Council, Willenhall.
1894 Jan. 13	FENN, T...	Surveyor to the Urban District Council, Belper.
1887 Sept. 17 R1899 June 10	FIDDIAN, W.	Engineer to Stourbridge and Stour Valley Sewerage Boards. Old Bank Offices, Stourbridge.
P1899 Jan. 21	FIDLER, A., M. Inst. C.E. .. (*Member of Council.*)	Borough Engineer, Northampton.
G1891 June 25 T1906 Sept. 22	*FINCH, A. R., A. M. Inst. C.E.	Borough Surveyor, Kensington.
G1898 June 30 T1904 Jan. 23	*FINCH, E. E., A. M. Inst. C.E.	Borough Engineer, Bethnal Green.
1904 Nov, 18	FINDLAY, J. R.	Burgh Surveyor, Leith, N.B.
1894 Jan. 13	FINDLAY, R., A.M. Inst. C.E.	Surveyor, Eltham Green, S.E.
G1892 May 28 T1897 Jan. 16 R1903 July 25	*FITTON, G.	Thornfield, Urmston Lane, Stretford, Manchester.

Date of Election and Transfer.		
1903 May 16	FITZMAURICE, M., C.M.G., M. Inst. C.E.	Chief Engineer, London County Council, Spring Gardens.
1895 Oct. 19	FLEMING, M. J.	Borough Surveyor, Town Hall, Waterford.
1893 Jan. 14 B1899 May 6	FLOWER, T. J. M., Assoc. M. Inst. C.E.	Scottish Buildings, Baldwin Street, Bristol; and 28 Victoria Street, Westminster, S.W.
1906 Sept. 22	FORBES, A.	County Road Surveyor, Linlithgow, N.B.
G1895 July 27 T1899 Jan. 21	*FORBES, A. H.	Surveyor to the Urban District Council, Saffron Walden.
1896 Nov. 28	FORD, G...	City Surveyor, St. Albans.
1890 Sept. 13 B1905 Jan. 28	FOSTER, T.	51 State Insurance Buildings, Dale Street, Liverpool.
G1901 June 8 TA1901 Oct. 19 T1907 Sept. 7	*FOWLDS, W., A. M. Inst. C.E.	Borough Engineer, Keighley.
1873 May 2	FOWLER, ALFRED M., M. Inst. C.E. (*Past President.*)	1 St. Peter's Square, Manchester.
G1896 Jan. 18 TA1904 May 28 T1906 May 26	*FOX, S. F. L., Assoc. M. Inst. C.E.	Borough Surveyor, Luton.
1897 Mar. 13	FOX-ALLIN, C. J.	Surveyor to the Urban District Council, Smethwick.
G1898 June 30 T1902 Nov. 8	*FRASER, R. W.	Surveyor to the Urban District Council, Hoylake, Cheshire.
1895 Oct. 19	FROST, H.	Surveyor to the Urban District Council, Gosport and Alverstoke. Gosport.
1887 June 18 B1898 Jan. 15	FRY, W. H., A.M. Inst. C.E.	9 High Street, Gosport.
1877 Oct. 20	GAMBLE, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road, S.E.
1885 June 6	GAMMAGE, J.	Borough Surveyor, Dudley.
1891 Dec. 12 B1899 June 10	GARRATT, C. T.	Estate Office, Newtown Linford, Leicestershire.
1894 Mar. 3	GARRETT, J. H.	County Surveyor, Worcester.
1886 Mar. 13 B1902 Feb. 22	GASKELL, P.	Albert Chambers, Carr Lane, Hull.
1902 Jan. 25	GENT, T. W. B.	Surveyor to the Rural District Council, Leigh.
1902 Feb. 22	GEORGE-POWELL, J.	Surveyor to the Rural District Council, Godstone, Surrey.
1905 Jan. 28	GETTINGS, C. F.	Surveyor to the Urban District Council, Teignmouth.
1901 Oct. 19	GIBBS, A. G.	Surveyor to the Rural District Council, Midhurst, Sussex.
1900 Mar. 10	GIBSON, S.	Surveyor to the Urban District Council, Biddulph.
1889 Dec. 14	GINN, A. F.	District Surveyor to the Kent County Council, Tonbridge. 70 Quarry Hill, Tonbridge.

Date of Election and Transfer.		
1899 June 10	GLADWELL, A. (*Member of Council.*)	Engineer and Surveyor, Rural District Council, Eton. 160 High Street, Slough, Bucks.
1904 Jan. 23	GLEDHILL, G.	Surveyor to the Urban District Council, Balby with Hexthorpe.
1893 May 13	*GLOYNE, R.M., M. Inst. C.E.	District Engineer, Spring Gardens, S.W.
1895 Jan. 19	GOLDER, T. C.	Borough Surveyor, Deal.
1904 Feb. 27	GOLDSWORTHY-CRUMP, T. ..	Surveyor to the Rural District Council, Taunton. 8 St. George's Terrace, Wilton, Taunton.
1886 June 12	GOODYEAR, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
1897 June 19	GORDON, F.	Surveyor to the Rural District Council, Halifax. Clifton, Brighouse.
1899 June 10	GOUDIE, A. H.	Burgh Engineer, Stirling, N.B.
G1897 June 19 T1901 Dec. 7	*GRANT, F. T...	Borough Surveyor, Gravesend.
1905 Sept. 23	GRAY, C. C.	Surveyor to the Urban District Council, Hayes.
G1887 Feb. 5 PPT1893 Apr. 22	*GREATOREX, A.D., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, West Bromwich.
1895 Mar. 5	GREEN, A. A.	Borough Surveyor, Brackley.
1899 June 10	GREEN, G., A.M. Inst. C.E...	Borough Engineer, Wolverhampton.
1901 Feb. 16	GREEN, J. S.	Borough Engineer, Haslingden.
1897 Mar. 13	GREEN, W.	Surveyor to the Urban District Council, Castleford.
A1901 Dec. 7 T1903 Dec. 12	GREENSHIELDS, N., Assoc. M. Inst. C.E.	Borough Engineer, Bedford.
1890 May 3 R1898 Apr. 23	GREENWELL, A., Assoc. M. Inst. C.E.	30 Furnival Street, Holborn, E.C.
1898 Mar. 19	GREGORY, T.	Surveyor to the Urban District Council, Newburn-on-Tyne.
1892 Jan. 16	GREGSON, G.	Surveyor to the Rural District Council, Durham.
1886 Oct. 16	GREGSON, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
1882 Sept. 30	GRIEVES, R.	Surveyor to the Urban District Council, Blyth, Northumberland.
1897 June 19	GRIEVES, W. H.	Surveyor to the Urban District Council, Buxton.
1904 Oct. 29	*GRIFFITHS, H. LL., ...	Borough Surveyor, Brecon.
1886 Sept. 11	GRIMLEY, S. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hendon.
1899 Dec. 16	GRIMSHAW, F. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Atherton.
1908 June 25	GRIMWOOD, G. F.	Borough Engineer, Monmouth.
1898 Dec. 17	GUILBERT, T. J.	States Surveyor, Guernsey.
1892 Apr. 28	GUNNIS, J. W.	County Surveyor, Longford, Ireland.
1890 Mar. 29	GUNYON, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Wood Green, N.

Date of Election and Transfer.		
1891 Dec. 12	Hackett, E. A., M.E., M. Inst. C.E.	County Surveyor, Clonmel, Tipperary, Ireland.
1897 June 19	Hague, S.	Borough Surveyor, Dukinfield.
1885 June 6	Haigh, J., A.M. Inst. C.E. ..	Borough Surveyor, Abergavenny.
1906 June 28	*Hailstone, T. H.	Borough Surveyor, Richmond, Yorks.
1896 Apr. 25	Hainsworth, M.	Surveyor to the Urban District Council, Teddington.
1902 Sept. 6	Hale, A.	Municipal Engineer, Howrah, Bengal.
G1899 Dec. 16 T1901 Oct. 19	*Hall, C...	Surveyor to the Urban District Council, Droylsden, near Manchester.
1902 Nov. 8	Hall, E.	Borough Surveyor, Carnarvon.
1884 Apr. 19 R1903 Mar. 21	Hall, J., M. Inst. C.E. (*Member of Council.*)	Executive Engineer, Municipal Offices, Bombay. *Hon. Secretary*, Indian District.
1886 May 1	Hall, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Great Crosby.
1900 June 16	Hallam, R.	Surveyor to the Rural District Council, Eton.
1901 May 11	Haller, J. C.	Surveyor to the Urban District Council, Carlton, near Nottingham.
1905 June 22	*Halstead, B.	Surveyor to the Urban District Council, Brierfield, Lancs.
1894 July 7	Hamar, A.	Borough Surveyor, Bishop's Castle, Shropshire.
1887 Mar. 12	Hamby, G. H., Assoc. M. Inst. C.E.	Borough Engineer, Lowestoft.
1897 Feb. 13	Hamp, H. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, New Swindon.
1897 Mar. 13	Hanson, J. H.	Surveyor to the Urban District Council, Cottingham, Yorks.
1890 Sept. 13	Hanson, W.	Surveyor to the Urban District Council, Wantage.
1896 Jan. 18	Hara, R.	City Engineer, Yokohama, Japan.
1873 Feb. 15 R1903 Jan. 17	Harding, J. R.	Ashley Road, Epsom, Surrey.
1899 June 29	*Hargreaves, J. E.	Surveyor to the Urban District Council, Farnborough, Hants.
1899 May 6	Harman, E. A., M. Inst. C.E.	Corporation Gas Engineer, Huddersfield.
1897 Mar. 13	Harpur, A. O.	Surveyor to the Urban District Council, Caerphilly.
1905 Jan. 28	Harpur, J. L.	Town Surveyor, Brierley Hill.
1894 Mar. 3	HARPUR, W., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Cardiff.
1896 Jan. 18	Harris, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough, Tunbridge Wells.
G1901 June 8 T1907 Jan. 19	Harris, K. J. S.	Borough Surveyor, Wisbech.

Date of Election and Transfer.		
1901 May 11	HARRISON, A., M.Inst.C.E. ..	Borough Engineer, Southwark. Town Hall, Walworth Road, S.E.
1906 Apr. 28	*HARRISON, E. Y., Assoc. M. Inst. C.E.	Surveyor and Water Engineer to the Urban District Council, Wellingborough.
1899 June 29	HARRISON, G. F. P.	Surveyor to the Rural District Council, East Stow. Stowmarket, Suffolk.
G1900 Mar. 19 T1905 Mar. 3	*HARRISON, J. W.	Surveyor to the Urban District Council, Wombwell, Yorks.
1896 Nov. 28 R1904 Jan. 23	HARSTON, W., A.M. Inst. C.E.	8 Hythe Street, Dartford.
1905 Sept. 23	HART, G. A.	Sewerage Engineer, Municipal Buildings, Leeds.
1896 Oct. 24	HARTLEY, T. H.	Borough Surveyor, Colne.
1893 Oct. 21	HARVEY, T. F., Assoc. M. Inst. C.E.	Borough Engineer, Merthyr Tydvil.
1907 Apr. 27	HAWKE, W. C., A.M. Inst. C.E.	Borough Surveyor, Dover.
1889 Feb. 9	HAWKINS, I. T., Assoc. M. Inst. C.E.	Director of Public Works, Lagos.
1906 Dec 15	HAWKINS, J. F.	County Surv., Roads & Bridges, Berkshire. Reading.
1892 Apr. 23	HAWLEY, G. W.	Highway Surveyor R.D.C., Basford. Burton Buildings, Parliament St., Nottingham.
1902 July 10	HAYNES, H. T., Assoc. M.Inst. C.E.	City Engineer, Perth, West Australia.
1895 Apr. 20	HAYNES, R. H., M. Inst. C.E.	Borough Engineer, Newport, Mon.
G1897 June 19 T1898 Jan. 15	*HAYWARD, T. W. A., A.M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Town Hall, Battersea.
G1899 Jan. 12 T1903 June 25	*HAYWOOD, S. S.	Borough Engineer, Brighouse.
1907 Mar. 2	HEAP, J. A.	Borough Surveyor, Todmorden.
1899 June 10	HEATH, J.	Surveyor to the Urban District Council, Urmston.
1885 June 6	HEATON, G., Assoc. M. Inst. C.E.	Surveyor to the Urban Dist. Councils, Abram and Pemberton. King Street, Wigan.
1890 Feb. 1 R1908 Jan. 18	HENDERSON, A. J., Assoc. M. Inst. C.E.	"Bramley," Killarney Road, Wandsworth, S.W.
G1895 June 27 T1901 Oct. 19	*HENDRY, J. S.	Surveyor to the Urban District Council, Cannock, Staffs.
1897 Feb. 13	HENRY, T.	Surveyor to the Rural District Council, East Retford.
1903 Dec. 12	HENSHAW, R. S.	Surveyor to the Urban District Council, Portland.
1892 June 11	HERON, J., B.E., B.A.	County Surveyor, Co. Down. Courthouse, Downpatrick, Ireland.
1902 May 10	HESLOP, R.	Surveyor to the Urban District Council, Tanfield, co. Durham
1875 Dec. 21	HEWSON, T., M. Inst. C.E. ..	159 Moorside Road, Flixston.
1894 July 7	HIGGENS, T. W. E., Assoc. M. Inst. C.E.	Borough Surveyor, Town Hall, Chelsea, S.W.
1898 May 21	HIGGINS, J.	Chief Engineer, Grey Co., New Zealand.

Date of Election and Transfer.		
G1903 Oct. 17 T1906 Nov. 3	*Hill, H. F.	Surveyor to the Urban District Council, Ware.
1898 Dec. 17	Hinchcliffe, D.	Surveyor to the Urban District Council, Shepton Mallet.
1902 July 10	*Hines, C. E.	Surveyor to the Urban District Council, Windermere.
1898 Sept. 3	Hirst, R. P., A.M. Inst. C.E.	Borough Surveyor, Southport.
1895 June 27	Hodgson, W.	Surveyor to the Urban District Council, Keswick.
1896 Apr. 25 R1901 May 11	*Hogbin, L. W.	"Rowena," Preston Road, Leytonstone, N.E.
1897 Jan. 16	Hole, W. P.	Borough Surveyor, Montgomery. Crowther's Hall, Welshpool.
1904 Aug. 16	Holmes, F. G.	Burgh Surveyor, Govan, N.B.
1892 Mar. 11	Holmes, G. W., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Walthamstow, N.E.
G1903 Dec. 12 T1904 Oct. 29	*Holt, R. B.	Permanent Way Engineer, Wellington Bridge, Leeds.
1901 Dec. 7	*Holt, W., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Sale, Cheshire.
1884 Oct. 9	Hooley, Cosmo C., Assoc. M. Inst. C.E.	Croft's Bank House, Davyhulme, nr Manchester.
1884 Oct. 9	HOOLEY, E. P., M. Inst. C.E. *(President.)*	County Surveyor, Nottingham.
1898 Jan. 15	Hopkinson, F.	Surveyor to the Rural District Council, Blyth and Cuckney. 66 Bridge Street, Worksop.
1891 Dec. 12	Horan, J., M.E., M.Inst.C.E.	County Surveyor, 82 George Street, Limerick, Ireland.
A1902 Feb. 22 T1906 Nov. 3	Horton, J. W., Assoc.M.Inst. C.E.	County Surveyor, Derbyshire.
1894 Mar. 3	Howard, H.	Surveyor to the Urban District Council, Littlehampton.
P1889 Dec. 14 R1898 Oct. 15	Howard-Smith, W., Assoc. M. Inst. C.E.	"Arosa," Amersham Hill, High Wycombe.
1880 May 27	Howcroft, J.	Surveyor to the Urban District Council, Redcar, Yorkshire.
1894 June 21	Howell, F. G.	County Surveyor, Surrey. Kingston-on-Thames.
1896 Feb. 22	Howse, W. T.	Surveyor to the Urban District Council, Bexley.
1897 June 17	Hughes, H. T.	Highway Surveyor, Hayfield Road, Chapel-en-le-Frith.
1897 Jan. 16	Humphreys, J.	Surveyor to the Urban District Council, Maesteg.
1899 June 1	Humphries, H. H.	Surveyor to the Urban District Council, Erdington.
1894 June 21	Hunt, G. J.	Borough Engineer, Dorchester.
1897 July 8	Hunter, T.	Surveyor to the Urban District Council, Leigh.
G1891 Aug. 1 T1896 Apr. 25	*Hurd, H.	Surveyor to the Urban District Council, Broadstairs.
G1901 Aug. 24 T1901 Dec. 7	*Hutton, F.	Surveyor to the Urban District Council, Ashton-on-Mersey.
A1902 Feb. 22 T1903 Mar. 21	Hutton, S.	Surveyor to the Urban District Council, Exmouth.

Date of Election and Transfer.		
1898 May 21 R1906 Mar. 3	INGAMELLS, E. W.	Surveyor, Pokesdown.
G1895 Apr. 20 T1896 Oct. 24	*INGHAM, W., A.M. Inst.C.E.	Hydraulic Engineer, Port Elizabeth, South Africa.
1899 Feb. 25	INGRAM, S.	County Surveyor, Devon. Exeter.
1888 Nov. 17	IRVING, W. E.	Town Surveyor, Toowong, Queensland, Australia.
1893 June 24 R1902 Nov. 8	ISAACS, L. H., A. Inst. C.E. ..	3 Verulam Buildings, Gray's Inn, W.C.
1904 May 28	IVESON, J. A.	Surveyor to the Rural District Council, 2 Nares Street, Scarborough.
1900 July 19	JACK, G. H.	County Surveyor, Herefordshire.
1893 Oct. 21	JAFFREY, W.	Town Surveyor, Matlock Bath.
1896 Oct. 24	JAMES, A. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Grays Thurrock. Grays.
1903 Dec. 12	JAMES, C. C., M.Inst.C.E. ..	The Ministry, P.W.D., Cairo. 28 Victoria Street, S.W.
G1887 Oct. 22 T1890 Mar. 29	*JAMESON, M. W., A. M.Inst. C.E.	Borough Engineer, Stepney. Gt. Alie St., Whitechapel, E.
1897 Feb. 13	JARVIS, R. W.	Surveyor to the Rural District Council, Tenbury.
1885 Apr. 18	JEEVES, E.	Surveyor to the Urban District Council, Melton Mowbray.
G1898 Jan. 15 T1903 Oct. 17	*JEFFES, R. H., A. M. Inst. C.E.	Surveyor to the Urban District Council, Malden.
G1896 Jan. 18 T1896 Oct. 24	*JENKIN, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Finchley, N.
1899 June 10	JENKINS, D. M., A.M.Inst.C.E.	Borough Surveyor, Neath.
1907 Jan 19	JENKINS, J. P.	Borough Surveyor, Penryn, Cornwall.
1880 Feb. 7 R1908 Feb. 29	JENNINGS, G.	9 Nelson Street, Rotherham.
1895 May 25	JEPSON, J.	Surveyor to the Urban District Council, Levenshulme.
G1900 June 16 A1901 Oct. 19 AM1907 Nov. 2 T1908 May 23	*JERRAM, G., A.M. Inst. C.E.	Surveyor to the Urban District Council, Merton.
1892 July 21	JEVONS, J. H., A. M. Inst. C.E.	Borough Surveyor, Hertford.
1904 May 28	JOHNSON, J.	Borough Surveyor, Rawtenstall.
1895 June 27	JOHNSTON, J., M. Inst. C.E.	Waterworks Engineer, Brighton.
1883 Aug. 4 R1902 Nov. 8	JONES, V.C., Lt.-Col. A. S., M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
1873 Feb. 15	JONES, CHAS., M. Inst. C.E. *(Past President and Gen. Hon. Secretary. Member of Council.)*	Borough Surveyor, Ealing, Middlesex.
1894 July 7	JONES, CHRISTOPHER	Borough Surveyor, Hythe, Kent.
G1903 May 16 T1904 June 26	*JONES, F. W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Frome, Somerset.
1874 Jan. 29	JONES, I. M., M. Inst. C.E.	Engineer to the Dee Bridge Commissioners.

Date of Election and Transfer.		
1894 June 21	Jones, J.	Surveyor to the Rural District Council, Hengoed, *viâ* Cardiff.
1894 June 21	Jones, J. O.	Surveyor to the Rural District Council, Biggleswade.
1903 June 6	Jones, R. R.	Surveyor to the Urban District Council, Horsforth.
1900 Mar. 10	Jones, T. C.	Surveyor to the Urban District Council, Frimley. Camberley, Surrey.
1892 May 28	Jones, W., Assoc.M.Inst.C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Colwyn Bay. *Hon. Sec.*, North Wales District.
1897 Feb. 13	Jones, W. J.	Surveyor to the Urban District Council, Rhondda.
1898 Apr. 23	Jones, W. P.	Surveyor to the Urban District Council, Glyncorrwg.
1906 Dec. 15	Joyce, T. W.	Borough Engineer, Dartmouth.
1891 June 25	Jukes, W. H.	Surveyor to the Urban District Council, Tipton.
G1895 Oct. 19 AM1907 Nov. 2 T1908 June 25	*Julian, J., B.E.	Borough Surveyor, Cambridge.
1905 Oct. 28	*Kay, G. H.	Surveyor to the Urban District Council, Irlam, Lancs.
1895 July 27 R1899 Dec. 16	Kay, W. R., A.M. Inst. C.E.	Athol Street, Douglas, Isle of Man.
1892 Apr. 23	Kennedy, J. D.	Borough Surveyor, Retford.
1905 Jan. 28	*Kenyon, L.	Surveyor to the Urban District Council, Tottington.
1895 May 25	Keywood, H. G.	Borough Surveyor, Town Hall, Ossett.
1892 July 11	Kidd, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.
1899 Oct. 21	Killick, J. S.	Highway Surveyor to the Rural District Council, Croydon.
1899 June 29	Killick, P. G.	Borough Surveyor, Finsbury, E.C.
1902 May 10 R1903 July 25	Kinnison, A. M.	Abbey Cottage, Leek, Staffs.
1888 Sept. 15	Kirk, T., Assoc. M. Inst. C.E.	City Engineer, Brisbane.
1907 May 25	Kirkpatrick, C. R. S., A. M. Inst. C.E.	City Engineer, Newcastle-on-Tyne.
1895 Oct. 19	Knapp, R. W.	Borough Surveyor, Andover.
1903 June 25	*Knewstubb, F. W., A.M.Inst. C.E.	c/o Mrs. Nicholson, 319 MacGee Street, Winnipeg, Canada.
1903 June 25	*Knewstubb, J. J.	Surveyor to the Urban District Council, Penrith.
1894 Mar. 8 R1903 Jan. 17	Knight, J. M., A.M.Inst.C.E.	35 Bancroft Road, Mile End, E.
1907 Sept. 7	Kusakabe, B.	Chief Engineer to Municipality, Tokio, Japan.
1884 Oct. 9	Lacey, F. W., M.Inst.C.E. ..	Borough Engineer, Bournemouth.
G1893 Jan. 14 T1895 Mar. 16	*Lacey, G. W.	Borough Surveyor, Oswestry.

Date of Election and Transfer.		
1882 May 25 B1902 Jan. 25	LAFFAN, G. B., M. Inst. C.E.	Hardy's Chambers, Pietermaritzburg, S.A.
1900 Dec. 15	LAILEY, H. G. N.	Surveyor to the Urban District Council, Trowbridge.
1900 July 19	LAITHWAITE, V.	Surveyor to the Urban District Council, Turton.
1904 Apr. 30	LAMBERT, A. P.	P.W.D., Winchester House, Johannesburg, South Africa.
A1902 Mar. 29 T1905 Oct. 28	LANCASHIRE, W. T., Assoc. M.Inst. C.E.	City Engineer, Leeds.
1904 Oct. 13	LANDALE, G.	Burgh Surveyor, Musselburgh, N.B.
1891 June 6 B1908 Feb. 29	LANDLESS, J. T., Assoc. M. Inst. C.E.	4 Nicholas Street, Burnley.
1904 Aug. 25	LAWRIE, J. P.	Burgh Surveyor, Bo'ness, N.B.
1884 July 10	LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
1900 Mar. 10	LAWTON, C. H.	Surveyor to the Urban District Council, Warminster. Christchurch Cottage, Warminster, Wilts.
G1899 Oct. 21 T1901 May 11	*LEA, M., A. M. Inst. C.E. ..	City Surveyor, Truro.
1904 Aug. 31	LEE, J.	Burgh Surveyor, Paisley, N.B.
p1896 Oct. 24	LEEBODY, J. W.	County Surveyor, Co. Tyrone (S.).
1898 Mar. 19	LEETE, H. J. G.	County Surveyor, Huntingdon.
1880 Apr. 10	LEETE, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
1900 May 19	LEGG, E. I.	Borough Surveyor, Christchurch, Hants.
1894 May 19	LEIGH, W.	Borough Surveyor, Chorley.
1873 Feb. 15	LEMON, J., M. Inst. C.E. (*Past President.*)	Stockwell Lodge, The Avenue, Southampton.
1899 Oct. 21	LINES, E.	Engineer to the Rural District Council, Chesterfield.
G1896 July 25 T1899 Dec. 16 B1903 Feb. 21	*LIVERSEDGE, J. W.	Surveyor to the Urban District Council, Leigh-on-Sea, Essex.
1891 Mar. 21 B1901 Aug. 24	LIVINGSTONE, G., Assoc. M. Inst. C.E.	23 Milbury Avenue, Hove.
1907 May 25	LLOYD-DAVIES, D. E., Assoc. M. Inst. C.E.	Chief Engineer, The Municipality, Alexandria, Egypt.
G1895 May 25 T1900 Oct. 15	*LOBLEY, F. J., A.M.Inst.C.E.	City Surveyor, Chichester.
1873 May 2	LOBLEY, J., M. Inst. C.E. (*Past President. Member of Council.*)	Borough Engineer, Hanley, Staffordshire.
1896 June 25	LOCKE, W. R.	Borough Surveyor, Town Hall, Hemel Hempstead.
1889 Sept. 21	LOMAX, C. J., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Gorton. 37 Cross Street, Manchester.
1904 Mar. 26	LONGDIN, H. W.	Surveyor to the Urban District Council, Penge.
1896 Oct. 24	LONGFIELD, R. W. F., M. Inst. C.E.	County Surveyor, Co. Cork (W.). Bandon.
1903 Dec. 12 B1908 Feb. 29	LONGLEY, H. B.	District Surveyor, Town Hall, Manchester.
1902 Nov. 8	LORD, E. I.	Borough Engineer, Greymouth, New Zealand.

Date of Election and Transfer.		
1901 May 11	LOVEDAY, W. F. .. .. .. (*Member of Council.*)	Borough Surveyor, Stoke Newington, N. *Hon. Sec.* Metropolitan District.
1892 Jan. 16	LOVEGROVE, E. J., M. Inst. C.E.	Borough Engineer, Hornsey, N.
1897 July 8	LUMSDEN, J. L.	Burgh Surveyor, Kirkcaldy.
1896 July 25	LUND, C.	Surveyor to the Urban District Council, Cleckheaton.
1896 Oct. 24	LYNAM, F. J., Assoc. M. Inst. C.E.	County Surveyor, Co. Tyrone (N.).
G1888 July 12 T1897 Oct. 16	*LYNAM, G. T., M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
1891 Aug. 1	LYNAM, P. J.	County Surveyor, Louth. Dundalk, Ireland.
1873 May 2 B1900 Mar. 10	McBEATH, A. G., Assoc. M. Inst. C.E.	Montagu Road, Sale, Cheshire.
1905 Mar. 3	McBETH, M. B.	Surveyor to Mid-Argyll District, Argyllshire County Council, County Buildings, Lochgilphead, Argyllshire.
1883 May 30	MACBRAIR, R. A., M.Inst.C.E. (*Member of Council.*)	City Engineer, Lincoln. *Hon. Sec.* Eastern District.
1904 Aug. 24	McBRIDE, S.	Burgh Surveyor, Rutherglen, N.B.
1900 Feb. 10	McDERMID, C.	Surveyor to the Urban District Council, Eston.
1897 Feb. 13	McDONALD, A. B., M. Inst. C.E.	City Engineer, Glasgow.
1904 Oct. 29	MACGREGOR, J. M.	County Surveyor, Dornoch, Sutherland, N.B.
1897 Jan. 16	MACKENZIE, D.	County Surveyor, Dunfermline.
1895 Oct. 19	McKENZIE, J. McD.	Surveyor to the Rural District Council, Bucklow. Mossburn Bldgs., Stamford New Road, Altrincham.
1904 Oct. 1	MACKIE, G. D.	Water Engineer, Municipal Buildings, Clydebank, N.B.
1898 June 30	McKILLOP, R.	Burgh Surveyor, Perth, N.B.
1906 Mar. 3	*MADEN, J.	Borough Engineer, King Williamstown, S. Africa.
1898 Feb. 19	MADIN, W. B.	Surveyor to the Urban District Council, Rushden.
1886 Dec. 18	MAIR, H., M. Inst. C.E. ..	Borough Engineer, Hammersmith, W.
1892 July 21	MANNING, G. W.	Surveyor to the Rural District Council, Staines.
G1898 Jan. 15 T1901 Aug. 24	*MARKS, C. W...	Borough Surveyor, Wokingham.
1888 July 12	MARKS, H. C., M. Inst. C.E.	City Surveyor, Carlisle.
1899 May 6	MARKS, W. L.	Surveyor to the Urban District Council, Rhymney.
1897 Mar. 13	MARSHALL, J...	Surveyor to the Rural District Council, West Malling.
A1903 Jan. 17 T1907 Nov. 2	MARSHALL, L. P., M. Inst. C.E.	Chief Engineer, Rangoon Municipality.

Date of Election and Transfer.		
1891 Jan. 21 R1902 Nov. 8	MARSTON, C. F., Assoc. M. Inst. C.E.	Masonic Hall Chambers, Mill Street, Sutton Coldfield.
1894 Mar. 3 R1908 May 23	MARTEN, H. J., Assoc. M. Inst. C.E.	11 Victoria Street, S.W.
G1894 Jan. 13 T1907 Dec. 14	*MARTIN, E. B., A.M.Inst.C.E.	Borough Engineer, Rotherham.
1899 May 6	MASON, C. G., Assoc. M. Inst. C.E.	Borough Surveyor, Guildford.
1904 Oct. 22	MASSIE, C.	Water Engineer, Falkirk, N.B.
1890 Mar. 29	MASSIE, F., M. Inst. C.E. ..	Surveyor to the Rural District Council, Wakefield.
1904 Aug. 17	MASSIE, J.	Burgh Engineer, Edinburgh, N.B.
1906 Apr. 28	MATHER, H. T.	Surveyor to the Urban District Council, Surbiton.
1883 Feb. 17	MATHEWS, G. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Dorking.
1898 Dec. 17	*MATTHEWS, E. R., Assoc. M. Inst. C.E.	Borough Surveyor, Bridlington.
1904 May 28	MAUDSLEY, C. W.	Surveyor to the Rural District Council, Oakham, Rutland.
1881 Dec. 10	MAWBEY, E. G., M. Inst. C.E. (*Past President.*)	Borough Engineer, Leicester.
G1896 July 25 T1902 Sept. 6	*MAXWELL, W. H., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
G1898 Dec. 17 T1904 June 26	*MAY, C. G.	P.W.D., Sepoy Lines, Penang, S.S.
1894 Oct. 20	MAYBURY, H. P.	County Surveyor, Maidstone.
1901 Aug. 24	MAYLAN, S.	Surveyor to the Rural District Council, Basford.
1889 May 18	MAYNE, C., M. Inst. C.E. ..	Engineer and Surveyor to the Municipal Council, Shanghai. *Hon. Corresponding Sec.* for Eastern Asia.
1883 Feb. 17	MEADE, T. DE COURCY, M. Inst. C.E. (*Past President.*)	City Surveyor, Manchester.
1903 June 25 R1908 Jan. 18	*METCALFE, A. J.	District Main Road Surveyor, Ashbourne.
1893 June 24	MILLER, H., M. Inst. C.E. ..	County Surveyor, East Suffolk, Ipswich.
1902 July 10	MILLER, H.	Surveyor to the Urban District Council, Heysham.
1897 Jan. 16	*MILNES, G. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
1874 May 23	MITCHELL, J.	Borough Surveyor, Hyde, Manchester.
1896 Oct. 24	MONCUR, J., A.M. Inst. C.E.	County Highway Surveyor, County Buildings, Stafford.
1900 Dec. 15	MONTEATH, G.	County Surveyor, Newtown, St. Boswell's, N.B.
1898 Apr. 23	MORGAN, E. F.	Borough Road Surveyor, Croydon.
1907 May 25	MORGAN, E. L., A. M. Inst. C.E.	Borough Engineer, Bolton.
1895 July 27	MORGAN, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.

Date of Election and Transfer.		
1892 July 11	MORGAN, J.	Surveyor to the Rural District Council, Pontardawe. Swansea.
1901 June 8	MORGAN, R. P.	Surveyor to the Urban District Council, Towyn.
1874 May 1	MORGAN, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.
1905 Oct. 28	MORLEY, E.	Surveyor to the Urban District Council, Walthamstow.
1903 Feb. 21	MOULDING, T., A.M.Inst.C.E. (*Member of Council.*)	City Surveyor, Exeter. *Hon. Secretary*, Western District.
A1902 Jan. 25 T1902 June 7	MOUNT, J. C., A.M. Inst. C.E.	Borough Surveyor, Lancaster.
1885 Feb. 7 R1905 Jan. 28	MOUNTAIN, A. H., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Barton-on-Irwell. Green Lane, Patricroft, near Manchester.
1898 Sept. 3	MULVANY, C. J., M. Inst. C.E.	County Surveyor, Athlone.
1890 Mar. 29	MURCH, P.	Borough Engineer, Portsmouth.
1896 Nov. 28	MURPHY, P. E., M.Inst. C.E.	Engineer to the Tottenham and Wood Green Joint Drainage Committee. Council Buildings, Tottenham, N.
1904 Aug. 6	MURRAY, J.	County Surveyor, Renfrewshire. Paisley, N.B.
1904 Aug. 17	MURRAY, J.	Burgh Surveyor, Port Glasgow, N.B.
1895 Feb. 16 R1904 Jan. 23	MURZBAN, KHAN BAHADUR M. C., C.I.E., M. Inst. C.E.	"Gulestan," Murzban Road, Bombay.
1896 Oct. 24	NANKIVELL, H. H.	Surveyor to the Urban District Council, Braintree.
G1903 Oct. 17 T1905 May 27	*NASH, F. O. C., Assoc. M.Inst. C.E.	Town Hall, Bethnal Green, N.E.
1905 Oct. 28	NELSON, G., A.M.Inst. C.E.	Surveyor to the Urban District Council, Gosforth.
1897 July 8	NEWMAN, S. J.	Borough Surveyor, Poole.
1897 Feb. 13 R1903 Jan. 17	NEWTON, C. E.	19 Cooper Street, Manchester.
G1895 Jan. 19 TA1901 Oct. 19 T1902 Mar. 22	*NEWTON, E. B., A.M. Inst. C.E.	Borough Surveyor, Paddington, W.
1888 May 12	NEWTON, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
G1892 Sept. 24 T1899 Feb. 25	*NICHOLS, A. E., A.M. Inst.C.E.	Borough Engineer, Folkestone.
1904 Aug. 5	NISBET, T., Assoc. M.Inst.C.E.	Master of Works, City Chambers, Glasgow, N.B.
1887 July 14 R1899 Feb. 25	NORRINGTON, J. P., Assoc. M. Inst. C.E.	28 Dulwich Road, Brixton, S.E.
G1897 Mar. 13 T1898 Sept. 3	*NORRIS, J. H.	Borough Surveyor, Godalming.
1886 Dec. 18 R1901 May 11	NORRISH, G. R.	Hawley House, Tudor Road, Upper Norwood.
1900 Dec. 15	NUTTALL, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Kearsley.
1899 Feb. 25 R1908 Feb. 29	NUTTALL, W.	District Surveyor, 28 Crosby Road, Birkdale, Southport

Date of Election and Transfer.		
G1898 June 30 T1899 Oct. 21	*OAKDEN, R., A.M. Inst. C.E. ..	Surveyor to the Rural District Council, Newark.
A1902 Jan. 25 T1906 Nov. 3	OAKES, H. H...	Town Surveyor, Ventnor, I. of W.
1901 Aug. 24	O'HARA, H.	Surveyor to the Urban District Council, Ballymena, Ireland.
1892 Jan. 16	OXTOBY, W., M. Inst. C.E. ..	Borough Engineer, Camberwell, S.E.
1907 Mar. 2	PALK, D. S.	Engineer-in-charge, P. W. D., Cape Coast, W. Africa.
1896 Apr. 25	PALMER, F. W. J...	Surveyor to the Urban District Council, Herne Bay.
FP1900 Mar. 10	PALMER, P. H., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Hastings.
1905 Jan. 28	PANSING, J., A.M. Inst. C.E.I.	Town Surveyor, Wicklow.
1894 Apr. 6	PARDOE, J. C., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Barry, near Cardiff.
1876 May 1	PARKER, J., Assoc. M. Inst. C.E.	City Surveyor, Hereford.
1887 July 14 R1895 June 27	PARKER, J., A.M. Inst. C.E.	49 Denmark Villas, Hove, Brighton.
1896 Nov. 28 R1903 Feb. 21	PARKER, J. E., A.M. Inst. C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
1896 Oct. 24	PARKER, S. W.	Surveyor to the Urban District Council, Gainsborough.
1893 July 13	PARR, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
G1898 June 30 T1899 Oct. 21	*PARR, F. H.	Borough Surveyor, Lymington.
G1893 Jan. 14 T1894 Oct. 20 R1908 Jan. 18	*PARR, N.	Brunswick House, Brentford.
1905 June 22	*PARRY, E.	District Main Road Surveyor, Hertforshire. 66 Whimbush Road, Hitchin, Herts.
P1894 June 21	PATON, J. (*Vice-President.*)	Borough Engineer, Plymouth.
1905 June 22	PATTINSON, N. P.	Borough Surveyor, Gateshead.
1895 Jan. 19	PATTISON, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.
1897 Jan. 16	PEACOCK, T. J.	District County Surveyor, Holland County Council, Spalding.
1898 Dec. 17	PEARCE, F. W.	Surveyor to the Urban District Council, Twickenham.
1899 Oct. 21 R1908 June 25	PEET, H. F., M. Inst. C.E.	Hill Side, Standon, Herts.
1891 Dec. 12	PEIRCE, R., M. Inst. C.E. ..	Municipal Engineer, Singapore, S.S.
A1902 Mar. 22 T1906 Dec. 15	PHILLIPS, G. A., A.M. Inst. C.E.	County Surveyor, Glamorgan. Bridgend.
1889 May 18 R1908 Jan. 18	PHILLIPS, R., Assoc. M. Inst. C.E.	9 Belgrave Road, Gloucester.
1904 May 28	PHIPPS, F. R., Assoc. M. Inst. C.E.	Borough Surveyor, Basingstoke.

Date of Election and Transfer.		
1901 Aug. 24	PICK, S. P.	County Surveyor, Leicester. 6 Millstone Lane, Leicester.
1901 Oct. 19	PICKARD, J. E.	Borough Surveyor, Pontefract, Yorks.
1898 Apr. 23	PICKER, E.	Surveyor to the Rural District Council, Beverley.
PG1887 June 18 PPT1890 Sept. 13	*PICKERING, J. S., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Cheltenham.
1881 Dec. 10 R1884 May 29	PICKERING, R.	11 Lowther Street, Whitehaven.
G1894 Jan. 13 T1895 Oct. 19	*PICKLES, G. H., M. Inst. C.E.	Borough Engineer, Burnley.
1906 Mar. 3	PICTON, T. S...	Borough Engineer, Eccles.
P1881 Dec. 10	PLATT, S. S., M. Inst. C.E.	Borough Surveyor, Rochdale.
1893 Oct. 21	PLOWRIGHT, A. H...	2 Bury Street, Norwich.
1897 July 8	POOLE, H. C.	Surveyor to the Urban District Council, Wath-upon-Dearn.
1881 July 7	PORTER, R.	Borough Surveyor, Wakefield.
1899 Oct. 21	*PRESCOTT, A. E.	Borough Surveyor, Eastbourne.
1898 Mar. 19	PRESCOTT, W. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Tottenham, N.
1892 Jan. 16 R1908 Apr. 25	PRESS, W. J.	41 College Street, Burnham, Somerset.
G1894 June 21 T1899 June 29	*PRICE, A. J.	Surveyor to the Urban District Council, Lytham.
1904 Sept. 29	PRITTY, J.	Burgh Engineer, Selkirk, N.B.
1878 May 2	PROCTOR, J., M. Inst. C.E. ..	Mere Lawn, Bolton, Lancashire.
1892 May 28	PROUSE, O. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ilfracombe.
1904 Aug. 4	PURDIE, W. H.	Burgh Engineer, Hamilton, N.B.
1873 May 2	PURNELL, E. J.	Water Engineer, Coventry, Warwickshire.
1899 May 6	PURSER, W. B., A.M. Inst. C.E.	County Surveyor, Kesteven County Council. Grantham.
G1893 July 31 T1898 June 13	*PUTMAN, W. E., A. M. Inst. C.E.	Borough Surveyor, Morley.
1905 Dec. 9	PUTTEN, E. VAN, M.Inst.C.E.	Borough Engineer, Lewisham, Town Hall, Catford, S.E.
1886 Dec. 18 R1901 Oct. 19	RADFORD, J. C., A. M. Inst. C.E.	163 Upper Richmond Road, Putney, S.W.
1889 July 4	RAPLEY, W.	Surveyor to the Rural District Council, Dorking.
1908 May 23	RAWSON, G.	Surveyor to the Urban District Council, Worksop.
1898 Apr. 23	RAYNER, F. J.	Surveyor to the Urban District Council, Newhaven.
1878 May 1	READ, R., A.M. Inst. C.E. .. (*Member of Council.*)	City Surveyor, Gloucester.
G1897 June 19 TA1901 Dec. 7 T1904 Sept. 17	*REDFERN, J. L.	Borough Surveyor, Gillingham, Kent.
1897 Feb. 13	RENWICK, R.	Surveyor to the Urban District Council, Horsham.
1892 Mar. 11	REYNOLDS, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.

Date of Election and Transfer.		
1888 July 12 R1902 Feb. 22	Richards, R. W., M. Inst. C.E.	Town Clerk and City Engineer, Dunedin, New Zealand. *Hon. Corresponding Secretary* for Australasia.
1908 July 18	Richardson, F. W.	Borough Engineer, Aston Manor.
1888 May 12	Richardson, H., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Handsworth, Birmingham. *Hon. Secretary* Midland District.
1884 Oct. 9	Richardson, J.	County Surveyor, Rutland. Stamford.
1901 May 11	*Ridler, W.	Borough Surveyor, Tewkesbury.
1892 Mar. 11	Ridout, A. R.	Surveyor to the Urban District Council, Stone.
G1901 Aug. 24 TA1905 Dec. 9 T1906 June 28	*Riley, J.	Sewerage Engineer, Johannesburg, Transvaal, S.A.
G1891 Dec. 12 T1897 Mar. 13	*Roberts, F., A. M. Inst.C.E.	Borough Engineer, Worthing.
1891 Oct. 17	Robinson, W. P., A.M. Inst. C.E.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
1886 May 1	Robinson, W. J.	City Surveyor, Londonderry.
1876 May 1	ROBSON, O. C., M. Inst. C.E. (*Past President. Member of Council.*)	Surveyor to the Urban District Council, Willesden, Middlesex.
1896 Mar. 21	Rodwell, A.	Surveyor to the Rural District Council, Skipton.
1906 Sept. 22	Rogers, S. G.	Borough Engineer, Chard.
1896 Jan. 18	Rogers, W. E.	Surveyor to the Urban District Council, Rugely.
1904 Oct. 22	Ronald, D.	Burgh Engineer, Falkirk, N.B.
1895 Jan. 19	Ross, J. C., A.M. Inst. C.E. ..	Engineer of Water Supply, City Hall, Toowoomba, Queensland, Australia.
G1901 Feb. 16 T1905 Mar. 3	*Rothera, A.	Surveyor to the Urban District Council, Thornhill, near Dewsbury.
1880 Oct. 2 R1905 May 27	Rounthwaite, R. S., M. Inst. C.E.	3 Willis Street, Wellington, New Zealand.
1888 May 12	Ruck, F. W.	County Architect, 86 Week Street, Maidstone.
1895 Feb. 16	Rushbrooke, T. J.	Borough Surveyor, High Wycombe.
1896 Apr. 25	*Rushton, E.	Surveyor to the Urban District Council, Cleethorpes.
A1903 Mar. 21 T1904 Sept. 17	Ryman, F. R., A.M.Inst.C.E.	Borough Surveyor, Stamford.
1890 Mar. 29 R1904 Mar. 26	*Saise, A. J., Assoc. M. Inst. C.E.	Eagle Insurance Buildings, Baldwin Street, Bristol.
1899 Feb. 25	Salkield, T.	Chief Engineer to Municipality of Delhi, India.
A1903 June 25 T1906 Dec. 15	*Saunders, E. Y.	Borough Surveyor, Barnstaple.
G1887 June 18 T1898 May 21 R1903 Mar. 21	*Saunders, J., A.M. Inst. C.E.	24 Market Place, Newark.
1894 Mar. 3	Saville, J.	Town Surveyor, Heckmondwike.
1899 May 6	Schofield, W. H., A.M. Inst. C.E.	County Surveyor, Lancashire. County Hall, Preston.

Date of Election and Transfer.		
1894 June 21	SCORGIE, N., M. Inst. C.E. ..	Boro' Surveyor, Hackney, N.E.
1892 Sept. 24	SCOTT, A. F.	Surveyor to the Urban District Council, Cromer.
1888 Nov. 17	SCOTT, H. H., A.M.Inst.C.E.	Engineer to the Commissioners, Hove.
1880 May 27	SCOTT, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
1897 Feb. 13	SCOTT, T.	Surveyor to the Rural District Council, Tadcaster, Aberford, near Leeds.
1904 Aug. 4	SCOTT, T. H	Burgh Surveyor, Inverness, N.B.
1908 Jan. 18	SEAVER, T. W., B. Eng. (New Royal).	Municipal Engineer, North Sydney, N.S.W.
1897 July 8	SENIOR, C. E...	Surveyor to the Urban District Council, Neston, Cheshire.
1896 Oct. 24	SENIOR, J. S.	Surveyor to the Urban District Council, Swanage.
G1894 July 7 T1898 Mar. 19	*SETTLE, J. A., A.M.Inst.C.E.	Borough Engineer and Surveyor, Heywood, Manchester.
A1902 Nov. 8 T1907 Mar. 2	*SHACKLETON, W., A. M. Inst. C.E.	Borough Surveyor, Grantham.
1896 Nov. 28	SHARPE, J. E.	Surveyor to the Urban District Council, Cheshunt.
1891 June 6	SHAW, H., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Ilford.
1890 June 7 R1901 Aug. 24	SHAW, J. H.	Surveyor to the Urban District Council, Brownhills, Staffs.
1892 May 28	SHEARD, W. C., Assoc.M. Inst. C.E.	Surveyor to the Urban District Council, New Mills. "Stonelea," New Mills, near Stockport.
1905 June 22	SHELL, W. S.	Surveyor to the Urban District Council, Consett, Durham.
1891 Oct. 17	SHEPHERD, G. J.	Surveyor to the Rural District Council, Kidderminster.
1884 June 10	SHEPPARD, G.	Borough Surveyor, Newark.
A1905 May 27 T1907 May 25	SHERREN, A. O., A.M.Inst.C.E.	Surveyor to the Urban District Council, Cheriton.
1892 July 11	SHILLINGTON, H., M.E. ..	Town Surveyor, Lurgan, Ireland.
1895 Oct. 19	SHIPTON, T. H.	Surveyor to the Urban District Council, Oldbury.
1902 June 7	SIDDALLS, J.	Borough Surveyor, Tiverton.
1887 Oct. 22	SIDDONS, J. M.	Surveyor to the River Nene Commissioners, Oundle.
1896 Jan. 18	SIDWELL, H. T.	Surveyor to the Rural District Council, Rochford. Rayleigh, Essex.
P1887 July 14 R1898 Oct. 15	*SILCOCK, E. J., M. Inst. C.E.	11 Tothill Street, Westminster.
1897 Mar. 13	SILCOCK, H.	Surveyor to the Rural District Council, Blackwell. 67 Westgate, Mansfield.
1903 Oct. 17	SIMMONDS, T. B.	Surveyor to the Urban District Council, New Malden.
1904 May 28	*SIMMONS, R.	Surveyor to the Urban District Council, Little Woolton, near Liverpool.

Date of Election and Transfer.		
1901 Feb. 16	SIMPSON, H. FARR	County Surveyor, Northern Division, Isle of Ely. Wisbech.
1891 Aug. 1 R1895 June 27	SIMPSON, W. H., A. M. Inst. C.E.	Horsefair Street, Leicester.
1906 Dec. 15	SIMS, A.	Surveyor to the Rural District Council, Ashford.
1890 Sept. 13	SINCLAIR, J. S., A.M. Inst. C.E.	Borough Surveyor, Widnes.
1908 July 18	SINNOTT, E. S., M. Inst. C.E.	County Surveyor, Gloucestershire. Gloucester.
1895 Oct. 19	SKELTON, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
1898 Oct. 15	SMAIL, J. M., M. Inst. C.E. ..	Chief Engineer to the Metropolitan Board of Works, Sydney, N.S.W.
1898 June 30	SMALES, J. E.	Surveyor to the Urban District Council, Leatherhead.
1895 June 27	SMILLIE, J. F.	Borough Surveyor, Tynemouth.
1892 Mar. 11	SMITH, C. CHAMBERS	Surveyor to the Urban District Council, Sutton, Surrey.
1902 Sept. 6	SMITH, F. H.	Surveyor to the Urban District Council, Portishead.
G1904 May 28 T1904 Sept. 17	*SMITH, F. HALL	Surveyor to the Urban District Council, Sheringham.
1899 Mar. 25	SMITH, H. W., A.M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Scarborough. *Hon. Secretary*, Yorkshire District.
1897 May 15	SMITH, JAMES	Borough Surveyor, Buckingham.
1895 May 25	SMITH, J. B.	Surveyor to the Urban District Council, Tyldesley.
1901 Dec. 7	SMITH, J. GOULD, A.M. Inst. C.E.	Borough Surveyor, Beverley.
1905 Jan. 28	*SMITH, J. H. WOOLSTON, A. M. Inst. C.E.	Surveyor to the Urban District Council, Minehead.
G1898 Dec. 17 TA1901 Oct. 19 T1903 Oct. 17	*SMITH, J. WALKER	Borough Surveyor, Barrow-in-Furness.
1904 Aug. 6	SMITH, P. C.	Burgh Surveyor, Arbroath, N.B.
P1891 Dec. 12	SMITH, T. R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
1897 Jan. 16	SMITH, V.	Borough Surveyor, Chesterfield.
G1888 Jan. 14 T1897 Mar. 13	*SMITH-SAVILLE, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
1898 Jan. 15 R1907 Jan. 19	SNELL, J. F. C., M. Inst. C.E.	Caxton House, Westminster, S.W.
1903 Oct. 17	SOWDEN, M.	Surveyor to the Urban District Council, Whitchurch, Salop.
1898 Dec. 17	SPENCER, J.	Surveyor to the Urban District Council, Oakworth. York Chambers, Cooke Street, Keighley.
1873 May 2 R1881 Dec. 10	SPENCER, J. P., A.M. Inst. C.E.	30 Howard Street, North Shields.
1902 May 10	SPENCER, L. G. P., A.M. Inst. C.E.	Borough Engineer, Inglewood, New Zealand.
G1899 Dec. 16 TA1901 Oct. 19 T1904 July 14	*SPRECKLEY, J. A., Assoc. M. Inst. C.E.	Borough Surveyor, Ludlow.

Date of Election and Transfer.		
A1901 Dec. 7 T1908 May 28	SPURR, F. W...	City Engineer, York.
A1904 May 28 T1906 Nov. 3	SPURRELL, E. F.	Borough Surveyor, Holborn.
1880 Feb. 7 R1899 June 10	STAINTHORPE, T. W., A.M.Inst. C.E. (*Member of Council.*)	P.W.D., Cape Town, South Africa. *Hon. Sec.*, African District.
1889 Dec. 14	STALLARD, S., A.M. Inst. C.E.	County Surveyor, Oxfordshire. Oxford.
1892 Mar. 11	STEPHENSON, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
1892 Mar. 11	STEVENSON, A.	County Road Surveyor, Ayrshire County Council. Ayr.
1891 Oct. 17	STEVENSON, J.	Surveyor to the Urban District Council, East Molesey.
1901 Feb. 16	STEWART, J.	Borough Engineer, Dunstable, Beds.
1891 June 25	STICKLAND, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
1897 Jan. 16	STILGOE, H. E., M. Inst. C.E. (*Member of Council.*)	City Engineer, Birmingham.
1900 Dec. 15	STIVEN, E. E.	Borough Surveyor, Whitehaven.
1904 Jan. 23	*STONES, J.	Surveyor to the Rural District Council, Sedgfield, co. Durham.
1898 Mar. 19	STOW, J. F.	Surveyor to the Rural District Council, Uxbridge.
1903 Mar. 11	STREATHER, W. T., A.M.Inst. C.E.	Surveyor to the Urban District Council, Waltham Cross.
1880 May 27	STUBBS, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
G1892 July 11 T1892 Sept. 24	*SUMNER, F., M. Inst. C.E. ..	City Engineer, Guildhall, London, E.C.
G1907 Jan. 19 T1907 May 25	*SUNDERLAND, C. H.	Surveyor to the Urban District Council, Midsomer Norton.
1895 Mar. 16	*SURTEES, R. T.	Water Engineer to the Urban District Council, Newton-in-Makerfield. Newton-le-Willows, Lancs.
1904 Aug. 10	SUTHERLAND, J. R., A.M.Inst. C.E.	Chief Engineer, Water Department, City Chambers, Glasgow, N.B.
G1899 June 29 T1901 June 27	*SWALES, T. R.	Borough Surveyor, Maldon.
1880 June 23 R1889 Apr. 13	SWARBRICK, J., M. Inst. C.E.	30 St. Anns Street, Manchester.
1899 June 10	SYKES, M. H.	Borough Surveyor, Stockton-on-Tees.
G1902 Feb. 22 TA1904 Dec. 3 T1906 Nov. 3	*TAIT, W. L., A.M. Inst. C.E.	Borough Engineer, Sudbury, Suffolk.
1887 Mar. 12	TANNER, W.	County Surveyor, Monmouthshire. Newport.
1895 Mar. 16	TARBIT, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
1891 Mar. 21 R1903 Mar. 21	TAYLOR, H. W., Assoc. M. Inst. C.E.	St. Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.
G1898 Dec. 17 TA1902 Jan. 25 T1907 Sept. 7	*TAYLOR, J.	Borough Engineer, Walsall.

Date of Election and Transfer.		
G1900 Dec. 15 TA1903 May 16 T1907 May 25	*TAYLOR, P.	Surveyor to the Urban District Council, Hampton Wick.
1890 Sept. 13	TAYLOR, T. G.	Borough Surveyor, Ramsgate.
G1891 Sept. 12 T1897 Oct. 16	*TAYLOR, W. J., M. Inst. C.E.	County Surveyor, Hants. Winchester.
1892 Apr. 23	TERRILL, W.	Surveyor to the Urban District Council, Ashford, Kent.
1892 Mar. 11	*THOMAS, R. J., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Bucks. Aylesbury.
1890 May 3	THOMAS, T. J., A.M.Inst.C.E.	Surveyor to the Urban District Council, Ebbw Vale.
1902 May 10	THOMAS, W. B.	Surveyor to the Urban District Council, Southwick-on-Wear.
1887 Sept. 17	THOMAS, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath. *Hon. Secretary*, South Wales District.
1906 Nov. 3	THOMSON, J.	City Engineer, Dundee.
G1904 June 25 T1906 Nov. 3	THORP, W. O.	Surveyor to the Urban District Council, Malvern.
1891 Jan. 21	THORPE, J.	Surveyor to the Rural District Council, Macclesfield.
1898 Jan. 15	THROPP, J., M. Inst. C.E. ..	County Surveyor, Lincolnshire. 29 Broadgate, Lincoln.
G1898 June 30 T1903 Dec. 12	*TIFFIN, T. E., A.M.Inst.C.E.	Surveyor to the Urban District Council, Dartford, Kent.
G1891 June 6 T1893 Oct. 21	*TOMES, G. B., A.M. Inst. C.E.	Surveyor to the Urban District Council, Barnes, Mortlake.
1895 Mar. 16	TOOLEY, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
1890 May 3	TOWLSON, S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
1894 Oct. 20	TRAVERS, W. H.	Surveyor to the Urban District Council, Wallasey.
1897 Jan. 16	TRESSIDER, W. H...	Borough Surveyor, Falmouth.
1901 Feb. 16	TROWSDALE, T. J...	Surveyor to the Urban District Council, Annfield Plain. Hare Law, Annfield Plain, Co. Durham.
1893 Oct. 21	TURLEY, A. C., Assoc.M.Inst. C.E.	City Engineer, Canterbury.
1890 Oct. 18	TURNBULL, A. J.	Burgh Surveyor, Greenock, N.B
1897 Mar. 13	TURNER, H. H.	Surveyor to the Rural District Council, Limehurst, Lancs. 250 Oldham Road, Waterloo, near Ashton-under-Lyne.
1899 June 10	*TURNER, S.	Surveyor to the Rural District Council, Ashby-de-la-Zouche.
1898 June 30	TURRIFF, A. A.	Burgh Surveyor, Elgin, N.B.
1905 May 27	*UREN, F. C.	Surveyor to the Urban District Council, Aldershot.

Date of Election and Transfer.		
G1894 Jan. 13 T1901 Dec. 7 R1903 Feb. 21	*Veitt, L. J.	1 Pimlico Road, S.W.
1889 Sept. 21 R1903 Jan. 17	Ventris, A., Assoc. M. Inst. C.E.	160 Buckingham Palace Road S.W.
1897 June 19	Vincent, S. J. L., A. M. Inst. C.E.	Borough Surveyor, Newbury.
1894 June 21	Waddington, J. A. P., M. Inst. C.E.	Borough Engineer, Marylebone, W.
1907 Dec. 14	*Waithman, C. H...	Surveyor to the Urban District Council, Newmarket.
1902 June 7	Wakeford, J. P., A. M. Inst. C.E.	Surveyor to the Urban District Council, Bilston.
1888 July 12	Wakelam, H. T., M. Inst. C.E. (*Member of Council.*)	County Engineer, Middlesex. Guildhall, Westminster, S.W.
1898 Sept. 8	Walker, A. H., A. M. Inst. C.E.	Borough Surveyor, Loughborough.
G1900 Dec. 15 T1904 Jan. 23	*Walker, H.	Surveyor to the Urban District Council, Wealdstone.
1887 June 18	Walshaw, J. W.	Borough Surveyor, Peterborough.
1905 Sept. 23	Warburton, W. E.	Surveyor to the Urban District Council, Hornsea.
1899 Jan. 21	Ward, J., M. Inst. C.E. ..	Borough Engineer, Derby.
1904 Jan. 23	Ward, T., Assoc. M. Inst. C.E.	Borough Engineer, Lower Hutt. 4 Grey Street, Wellington, New Zealand.
1886 July 8	Wardle, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
G1900 May 19 T1905 Mar. 3	*Warlow, W. R.	Surveyor to the Urban District Council, Milton-next-Sittingbourne.
G1904 May 28 T1904 Sept. 17	*Warr, G. W.	Surveyor to the Urban District Council, Southwick.
1890 May 3	Waterhouse, D.	Surveyor to the Urban District Council, Watford.
1892 Mar. 11	Watkeys, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.
1887 June 18	Watson, J. D., M. Inst. C.E.	Engineer to the Birmingham, Tame and Rea Drainage Board, Council House, Birmingham.
1904 Aug. 10	Watson, W.	Burgh Surveyor, St. Andrews, N.B.
1889 Sept. 21	Watts, E. T.	Surveyor to the Rural District Council, Hadham and Stansted, Bishop's Stortford.
1893 Oct. 21 R1908 Jan. 18	Watts, W., M.Inst. C.E. ..	Kenmore, Wilmslow, Cheshire.
1887 June 18	WEAVER, W., M. Inst. C.E. (*Past President.*)	30 Lytton Grove, Putney Hill, S.W.
1897 Feb. 13	Webb, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore.
1905 Oct. 28	Webb, J. H.	Borough Surveyor and Water Engineer, King's Lynn.

Date of Election and Transfer.		
1901 Oct. 19	WEBSTER, J. W.	Surveyor to the Urban District Council, Cowes, Isle of Wight.
1905 Jan. 28	WEBSTER, R. A.	Town Engineer, Krugersdorp, Transvaal, S.A.
1882 Apr. 15	WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
1887 June 18 } R1903 Feb. 21 }	WESTON, G.	The Limes, Harrow Road, Pinner.
1889 Apr. 13 } R1903 Jan. 17 }	WESTON, H. J., Assoc. M. Inst. C.E.	24 Portland Street, Southampton.
1907 May 25	WHEELER, A. G.	Surveyor to the Urban District Council, Eastwood.
P1888 July 12	WHITE, A. E., M. Inst. C.E. .. (*Member of Council.*)	City Engineer, Hull.
1891 Oct. 17	WHITE, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County, Maryborough.
1900 Mar. 10	WHITE, J. N.	Borough Surveyor, Stalybridge.
1873 May 2	WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
1900 Aug. 25	WHYATT, H. G., A. M. Inst. C.E.	Borough Engineer, Great Grimsby.
1889 Feb. 9	WIKE, C. F., M. Inst. C.E. (*Vice-President.*)	City Surveyor, Sheffield.
1888 May 12	WILD, G. H.	Surveyor to the Urban District Council, Littleborough, near Manchester.
1896 Apr. 25	WILDING, J.	Surveyor to the Urban District Council, Runcorn.
1905 June 22	WILES, J. W.	Surveyor to the Urban District Council, Gorton, Lancs.
1884 May 29 } R1902 Nov. 8 }	WILKINSON, J. P., M. Inst. C.E.	301–304 Corn Exchange Chambers, Cathedral Street, Manchester.
1899 Mar. 25	WILKINSON, M. H.	Surveyor to the Urban District Council, Leyland.
1899 Feb. 25 } R1903 Mar. 21 }	WILKINSON, W.	Ashton House, Hemingbrough, E. Yorks.
1884 Oct. 9 } R1885 June 6 }	WILLCOX, J. E., M. Inst. C.E.	63 Temple Row, Birmingham.
1894 Mar. 3	WILLIAMS, H. DAWKIN	Surveyor to the Urban District Council, Ogmore and Garrw, Blackmill R.S.O., Bridgend.
1893 July 31	WILLIAMS, J. B.	Borough Surveyor, Daventry.
1897 May 15	WILLIAMS, M.	Coychurch, Bridgend.
1907 Mar. 2	WILLIAMS, T. T.	Surveyor to the Rural District Council, Swansea.
G1898 June 30 } A1901 Dec. 7 } T1908 Feb. 29 }	*WILLIS, E., A.M. Inst. C.E...	Surveyor to the Urban District Council, Chiswick.
1891 June 25	WILLMOT, J.	County Surveyor, Warwickshire. 6 Waterloo Street, Birmingham.
1904 Oct. 29	WILLOUGHBY, P. R. A., A.M. Inst. C.E.	Surveyor to the Urban District Council, Pontypridd.
1898 June 30	WILSON, A.	County Surveyor, Dumbartonshire.
1887 Sept. 17	WILSON, G.	Surveyor to the Urban District Council, Alnwick.

Date of Election and Transfer.		
1873 May 2 R1899 Feb. 25	WILSON, J.	Bankside, Bacup, Lancashire.
1884 May 29	*WILSON, J. B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cockermouth.
1904 Aug. 23	WILSON, J. R.	Burgh Surveyor, Helensburgh, N.B.
1907 Apr. 27	WILSON, W.	Town Surveyor, Portadown, Ireland.
1897 Oct. 16	WINNING, D.	Burgh Surveyor, Broughty Ferry, N.B.
1880 Oct. 2	WINSHIP, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon Berks.
1896 Feb. 22	WINTER, O. E., Assoc. M. Inst. C.E.	Borough Surveyor, Hampstead N.W.
G1900 May 19 TA1902 Jan. 25 T1902 Nov. 8	*WOLFENDEN, B. J., A.M.Inst. C.E.	Borough Engineer, Bootle.
1880 Feb. 7	WOOD, A. R.	Surveyor to the Urban District Council, Tunstall.
1894 Mar. 3	WOOD, F. J., A. M. Inst. C.E.	County Surveyor, Sussex East. Lewes.
1898 Apr. 23	WOOD, W. E...	Surveyor to the Urban District Council, Church.
1885 Oct. 3 R1903 Feb. 21	WOODBRIDGE, C. A.	Pinner House, Pinner, Middlesex.
1899 May 6	WOODWARD, F.	Surveyor to the Urban District Council, Stourbridge.
G1900 July 19 T1901 Oct. 19	*WOOTTON, A. S.	Surveyor, Urban District Council, Bradford-on-Avon.
1897 July 8	*WORRALL, E.	Surveyor to the Urban District Council, Stretford, Council Offices, Old Trafford.
1886 July 8	WORTH, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
G1893 July 13 T1899 Oct. 21 R1904 Dec. 3	*WRIGHT, J. A.	6 Unity Street, Bristol.
1892 May 28 R1908 Jan. 18	WYNNE-ROBERTS, R. O., M. Inst. C.E.	5 Victoria Street, Westminster, S.W.
1895 Jan. 19	YABBICOM, T. H., M.Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Bristol.
G1892 July 11 T1892 Sept. 24	*YATES, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
1894 June 21	YORK, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.
1904 Aug. 26	YOUNG, C.	Burgh Surveyor, Coatbridge, N.B.
p1900 May 19	YOUNG, J.	Burgh Surveyor, Ayr.
1899 Dec. 16	YOUNG, T.	Surveyor to the Rural District Council, Sunderland.
1900 May 19	YOUNG, W. P...	Surveyor to the Rural District Council, Wallsall.

ASSOCIATE MEMBERS.

* *Those Associate Members against whose name a star is placed have passed the examination and hold the Testamur of the Association.*
R *signifies re-election under By-law 5a.*
G *elected as Graduate.* A *elected as Associate.*
TA *transferred to Associate.* TAM *transferred to Associate Member.*

Date of Election and Transfer.		
1908 Feb. 29	Bains, T. T.	Surveyor, Rural District Council, South Shields.
A1906 Dec. 15 TAM1907 Nov. 2	Belsher, B. J., A.M.Inst.C.E.	Deputy Borough Engineer, 15 Gt. Alie Street, Stepney.
G1904 May 28 A1905 June 22 T1908 July 18	*Berridge, H. M. K., A.M.Inst. C.E.	Assistant Surveyor, Long Eaton.
G1898 June 30 TA1901 Oct. 19 TAM1907 Nov. 2	*Best, H. Storr, A. M. Inst. C.E.	Chief Assistant Surveyor, Urban District Council, Beckenham.
1908 Feb. 29	Carey, J. G.	Engineer and Surveyor, Heston and Isleworth Urban District Council.
G1904 May 29 A1907 May 25 TAM1908 May 23	*Cattlin, O., A. M. Inst. C.E.	Assistant Borough Engineer, Holborn.
1907 Sept. 7	*Chart, R.	Chief Assistant Surveyor, Rural District Council, Croydon.
G1898 Dec. 17 A1902 Mar. 22 TAM1908 Apr. 25	*Clews, C. A.	Deputy Borough Surveyor, Derby.
A1905 May 27 TAM1907 Sept. 7	Collins, H., A. M. Inst. C.E.	Deputy City Engineer, Norwich.
G1899 June 29 TA1902 Jan. 25 TAM1907 Dec. 14	*Collinge, T. P., A. M. Inst. C.E.	Deputy City Surveyor, Carlisle.
G1897 Feb. 13 A1901 Oct. 19 TAM1908 Apr. 25	*Collis-Adamson, A. C. ..	Assistant Borough Engineer, Hornsey, N.
A1902 Jan. 25 TAM1907 Dec. 14	Crooke, W. E. Froome ..	Chief Engineering Assistant, Middlesex County Council. 19 West Park Road, Kew Gardens.
1907 Dec. 14	Cullin, H. B.	Highways Surveyor, Rural District Council, Isle of Wight.
1908 July 18	Denton, A. J.	Borough Surveyor's Office, South Shields.
G1891 Sept. 12 TA1902 Sept. 6 TAM1907 Dec. 14	*Dolamore, F. P.	Deputy Borough Engineer, Bournemouth.

Date of Election and Transfer.			
G1898 Jan. 15 TA1903 Jan. 17 TAM1907 Nov. 2	*GODFREY, C. H., A. M. Inst. C.E.	Deputy Engineer, Shanghai Municipality.
1907 Sept. 7	GOODWIN, J. D.	Borough Engineer, Ashfield, N.S.W.
A1907 Apr. 27 TAM1908 Feb. 29	*GOOSEMAN, A. T.	Deputy Borough Engineer, Bootle.
1908 June 25	GORDON, T. W.	Assistant City Engineer, Nottingham.
A1902 Mar. 22 TAM1907 Dec. 14	HADFIELD, W. J.	Deputy City Surveyor, Sheffield.
G1897 June 19 A1901 Oct. 19 TAM1908 June 25	*HAIGH, W. H., A.M.Inst.C.E.	Chief Assistant City Engineer, Cardiff.
A1907 Mar. 2 TAM1907 Dec. 14	HARPUR, S. J.	Chief Assistant, Lt. Railways Dept., Middlesex County Council. Guildhall, Westmister, S.W.
1908 July 18	HICKS, W. R.	Deputy Borough Engineer, Ealing, W.
G1897 June 19 TA1902 Jan. 25 TAM1907 Dec. 14	*JOHNSTON, R. W.	Deputy Borough Engineer, Birkenhead.
G1901 June 8 A1904 Mar. 26 TAM1908 Feb. 29	*JONES, H. O.	Chief Assistant Borough Engineer, Folkestone.
1908 Apr. 25	*KING, G. R.	Deputy Surveyor, Urban District Council, Twickenham.
1907 Sept. 7	LANE, W. G.	Surveyor, Urban District Council, Tavistock.
G1901 May 11 A1901 Oct. 19 TAM1908 Apr. 25	*LISMER, A. B., A.M.Inst.C.E.	Assistant Engineer, Town Hall, Edmonton.
G1900 Apr. 21 A1901 Dec. 7 TAM1908 Feb. 29	*MILLER, G. F.	Chief Assistant Borough Engineer's Office, Hastings.
G1899 Oct. 21 A1904 June 25 T1908 July 18	*PLANT, W., A.M. Inst. C.E...	Engineering Assistant, Town Hall, Leicester.
A1902 Mar. 22 TAM1907 Dec. 14	RANSOM, W., A. M. Inst. C.E.	Assistant City Surveyor, Worcester.
1907 Sept. 7	RICHARDSON, H.	Deputy Borough Surveyor, Scarborough.
G1903 June 6 A1904 Mar. 26 TAM1908 Feb. 29	*ROSEVEARE, L., A.M.Inst.C.E.	Council House, Birmingham.
1907 Sept. 7	SIMS, S. B.	Borough Engineer, Hamilton, N.Z.

Date of Election and Transfer.		
G1899 Dec. 16 A1902 May 10 TAM1908 Feb. 29	*SLATER, F. J...	Assistant Surveyor, Town Hall, Camberwell, S.E.
A1907 Jan. 19 TAM1907 Nov 2	SNODGRASS, R., A.M.Inst.C.E.	Deputy Borough Engineer, Guildford.
G1895 Jan. 19 TA1901 Oct. 19 TAM1907 Nov. 2	*STEELE, W. J., A.M.Inst.C.E.	Deputy City Engineer, Bristol.
1908 Apr. 25	STEWART, R. T.	Council Offices, Feltham.
G1904 May 28 TAM1908 May 23	*SUTHERLAND, D. S.	Chief Assistant Surveyor, Southgate.
G1898 June 30 TAM1907 Nov. 2	*SUTTON, W. F.	Chief Assistant, Birmingham Water Supply. Water Offices, Broad Street, Birmingham.
A1905 Sept. 23 TAM1907 Nov. 2	SWARBRICK, G.	Deputy Borough Surveyor, Swansea.
G1902 July 10 TAM1908 Apr. 25	*TOMLINSON, J. W., A.M.Inst. C.E.	Chief Assistant Engineer, City Engineer's Office, Coventry.
G1900 June 16 TAM1907 Sept. 7	*TOWNER, H. V.	Acting Superintendent, Works and Surveys, P.W.D., Singapore.
G1904 May 28 TA1904 Dec. 3 TAM1907 Dec. 14	*WALTON, J. S.	Deputy Borough Engineer, Torquay.
G1902 July 10 TAM1908 Feb. 29	*WILKINSON, F., A.M.Inst.C.E.	Deputy Borough Engineer, Wimbledon, S.W.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS AND ASSOCIATE MEMBERS OF THE ASSOCIATION.

A.	*signifies*	Abroad.	Met.	*signifies*	Metropolitan District.
Af.	„	African District.	M.	„	Midland District.
E.	„	Eastern District.	N.	„	Northern District.
H.	„	Home District.	S.	„	Scottish District.
Ind.	„	Indian District.	W.N.	„	Welsh District (North).
I.	„	Irish District.	W.S.	„	„ „ (South).
L. & C.	„	Lancashire & Cheshire District.	West.	„	Western District.
			Y.	„	Yorkshire District.

TOWN.	DISTRICT.	NAME.
Aberdeen	S.	W. Dyack.
Abergavenny	West.	J. Haigh.
Abingdon	H.	G. Winship.
Abram	L. & C.	G. Heaton.
Accrington	L. & C.	W. J. Newton.
Acton	H.	D. J. Ebbetts.
Aldershot	H.	F. C. Uren.
Alexandria	A.	D. E. Lloyd-Davies.
Alnwick	N.	G. Wilson.
Altrincham	L. & C.	H. E. Brown.
Andover	H.	R. W. Knapp.
Annfield Plain	N.	T. J. Trowsdale.
Antrim (County)	I.	J. H. Brett.
Audenshaw	L. & C.	W. Clough.
Arbroath, N.B.	S.	P. C. Smith.
Argyllshire (County)	S.	M. B. McBeth.
Armagh	I.	J. C. Boyle.
„ (County)	I.	R. H. Dorman.
Ashby-de-la-Zouch	M.	S. Turner.
Ashfield, N.S.W.	A.	J. D. Goodwin.
Ashford	H.	W. Terrill.
„ (Rural)	H.	A. Sims.
Ashton-under-Lyne	L. & C.	J. T. Earnshaw.
Ashton-on-Mersey	L. & C.	F. Hutton.
Aston Manor	M.	F. W. Richardson.
Atherstone (Rural)	M.	H. J. Coleby.
Atherton	L. & C.	W. Clough.
„	L. & C.	F. H. Grimshaw.
Athlone (County)	I.	C. J. Mulvany.
Auckland, N.Z.	A.	W. E. Bush.
Ayr	S.	J. Young.
Ayrshire (County)	S.	A. Stevenson.
Bacup	L. & C.	W. H. Elce.
Balby with Hexthorpe	Y	G. Gledhill.
Ballymena	I.	H. O'Hara.
Banbury	H.	N. H. Dawson.

TOWN.	DISTRICT.	NAME.
Barking	H.	C. F. Dawson.
Barnes	H.	G. B. Tomes.
Barnstaple	West.	E. Y. Saunders.
Barrow-in-Furness	L. & C.	J. W. Smith.
Barry	W.S.	J. C. Pardoe.
Barton-upon-Irwell (Rural)	L. & C.	A. H. Mountain.
Basford (Rural)	M.	S. Maylan.
„ „ (Highways)	M.	G. W. Hawley.
Basingstoke	H.	F. R. Phipps.
Battersea	Met.	T. W. A. Hayward.
Beccles	E.	T. O. Cudbird.
Beckenham	H.	J. A. Angell.
Bedford	H.	N. Greenshields.
Bedford (County)	H.	W. H. Leete.
Belfast	I.	H. A. Cutler.
Belper	M.	T. Fenn.
„ (Rural)	M.	R. C. Cordon.
Benwell	N.	W. P. Pattison.
Berkshire (County)	H.	J. F. Hawkins.
Bermondsey	Met.	R. J. Angel.
Berwick-on-Tweed	S.	R. Dickinson.
Berwickshire (County), N.B.	S.	T. R. Atkinson.
Bethnal Green	Met.	E. E. Finch.
Beverley	Y.	J. G. Smith.
„ (Rural)	Y.	E. Picker.
Bexhill	H.	G. Ball.
Bexley	H.	W. T. Howse.
Biddulph	M.	S. Gibson.
Biggleswade	H.	T. Cockrill.
„ (Rural)	H.	J. O. Jones.
Bilston	M.	J. P. Wakeford.
Bingley	Y.	H. Bottomley.
Birkenhead	L. & C.	C. Brownridge.
Birmingham	M.	H. E. Stilgoe.
Bishop's Castle	M.	A. Hamar.
Bishop's Stortford	H.	R. S. Scott.
Blackburn	L. & C.	W. Stubbs.
Blackpool	L. & C.	J. S. Brodie.
Blackwell (Rural)	M.	H. Silcock.
Blyth (Northumberland)	N.	R. Grieves.
Blyth and Cuckney (Rural)	M.	F. Hopkinson.
Bognor	H.	O. A. Bridges.
Bolton	L. & C.	E. L. Morgan.
Bombay	Ind.	J. Hall.
Bo'ness, N.B.	S.	J. P. Lawrie.
Bootle	L. & C.	B. J. Wolfenden.
Boston, Lincs.	E.	G. E. Clarke.
Bournemouth	H.	F. W. Lacey.
Brackley	M.	A. A. Green.
Bradford	Y.	J. H. Cox.
Bradford-on-Avon	West.	A. S. Wootton.
Braintree	E.	H. H. Nankivell.
Brecon	W.	H. Ll. Griffiths.
Brentford	H.	J. W. Croxford.
Bridgwater	West.	F. Parr.
Bridgwater (Rural)	West.	W. A. Collins.
Bridlington	Y.	E. R. Matthews.
„ (Rural)	Y.	S. Dyer.
Brierfield	L. & C.	B. Halstead.
Brierley Hill	M.	J. L. Harpur.

TOWN.	DISTRICT.	NAME.
Brighouse	Y.	S. S. Haywood.
Brisbane	A.	T. Kirk.
Bristol	West.	T. H. Yabbicom.
Briton Ferry	W.S.	H. A. Clarke.
Broadstairs	H.	H. Hurd.
Bromyard	M.	J. D. Barra.
Broughty Ferry, N.B.	S.	D. Winning.
Brownhills	M.	J. H. Shaw.
Buckhurst Hill	E.	H. Tooley.
Buckingham	H.	J. Smith.
" (County)	H.	R. J. Thomas.
Bucklow (Rural)	L. & C.	J. McD. McKenzie.
Burnham	West.	W. H. Chowins.
Burnley	L. & C.	G. H. Pickles.
" (Rural)	L. & C.	S. Edmondson.
Burslem	M.	F. Bettany.
Burton-on-Trent	M.	G. T Lynam.
Bury	L. & C.	A. W. Bradley.
Buxton	M.	W. H. Grieves.
Caerphilly	W.S.	A. O. Harpur.
Camberwell	Met.	W. Oxtoby.
Cambridge	E.	J. Julian.
Cannock, Staffs	M.	J. S. Hendry.
Canterbury	H.	A. C. Turley.
Cape Coast	Af.	D. S. Palk.
Cardiff	W.S.	W. Harpur.
Carlisle	N.	H. C. Marks.
Carlton	M.	J. C. Haller.
Carnarvonshire (County)	W.N.	E. Evans.
"	W.N.	E. Hall.
Castleford	Y.	W. Green.
Chatham	H.	C. Day.
Cheadle, Staffs	M.	T. Bibbey.
Chelmsford	E.	C. Brown.
" (Rural)	E.	J. Dewhirst.
Chelsea	Met.	T. W. E. Higgens.
Cheltenham	West.	J. S. Pickering.
Cheriton	H.	A. O. Sherren.
Chesham	H.	P. C. Dormer.
Cheshire (County)	L. & C.	H. F. Bull.
Cheshunt	H.	J. E. Sharpe.
Chester	L. & C.	I. M. Jones.
Chesterfield	M.	V. Smith.
" (Rural)	M.	E. Lines.
Chesterton	E.	J. D. Bland.
" (Rural)	E.	J. Dunn.
Chichester	H.	F. J. Lobley.
Chippenham	West.	A. E. Adams.
Chiswick	H.	E. Willis.
Chorley	L. & C.	W. Leigh.
Christchurch	H.	E. I. Legg.
Church	L. & C.	W. E. Wood.
Clayton-le-Moors	L. & C.	A. Dodgeon.
Cleckheaton	Y.	C. Lund.
Cleethorpes	E.	E. Rushton.
Coalville	M.	L. L. Baldwin.
Coatbridge, N.B.	S.	C. Young.
Cockermouth (Rural)	N.	J. B. Wilson.

TOWN.	DISTRICT.	NAME.
Colchester	E.	H. Goodyear.
Colne	L. & C.	T. H. Hartley.
Colombo, Ceylon	Ind.	F. A. Cooper.
" "	Ind.	R. Skelton.
Colwyn Bay	W.N.	W. Jones.
Congleton	L. & C.	R. Burslam.
Consett	N.	W. S. Shell.
Conway (Rural)	W.N.	T. B. Farrington.
Cork	I.	J. F. Delany.
Cork (County), West	I.	R. W. Longfield.
Cottingham	Y.	J. H. Hanson.
Cowes, Isle of Wight	H.	J. W. Webster.
Crewe	L. & C.	G. Eaton-Shore.
Cromer	E.	A. F. Scott.
Croydon	H.	G. F. Carter.
" (Highways)	H.	E. F. Morgan.
" (Rural)	H.	R. M. Chart.
" (Rural) (Highways)	H.	J. S. Killick.
Cumberland (County)	N.	G. J. Bell.
Cupar (Fife) (County)	S.	T. Aitken.
Dartford	H.	T. E. Tiffen.
Dartmouth	West.	T. W. Joyce.
Daventry	M.	J. B. Williams.
Darwen	L. & C.	R. W. Smith-Saville.
Deal	H.	T. C. Golder.
Delhi	Ind.	T. Salkield.
Derby	M.	J. Ward.
" (County)	M.	J. W. Horton.
Devon (County)	West.	S. Ingram.
Dewsbury	Y.	H. Dearden.
Doncaster (Rural)	Y.	W. Crabtree.
Dorchester	West.	G. J. Hunt.
Dorking	H.	G. S. Mathews.
" (Rural)	H.	W. Rapley.
Douglas, Isle of Man	L. & C.	F. Cottle.
Dover	H.	W. C. Hawke.
Down (County)	I.	J. Heron.
Driffield (Rural)	Y.	T. C. Beaumont.
Droylsden	L. & C.	C. Hall.
Dublin (County)	I.	W. Collen.
Dudley	M.	J. Gammage.
Dukinfield	L. & C.	S. Hague.
Dumbartonshire (County)	S.	A. Wilson.
Dundee	S.	J. Thomson.
Dunfermline (County)	S.	D. MacKenzie.
Dunoon, N.B.	S.	J. Andrew.
Dunstable	M.	J. Stewart.
Durham (Rural)	N.	G. Gregson.
Ealing	H.	C. Jones.
East Barnet Valley	H.	H. York.
East Ham	H.	A. H. Campbell.
East Molesey	H.	J. Stevenson.
East Retford (Rural)	M.	T. Henry.
East Stow (Rural)	E.	G. F. P. Harrison.
Eastbourne	H.	A. E. Prescott.
Eastwood	M.	A. G. Wheeler.

TOWN.	DISTRICT.	NAME.
Ebbw Vale	West.	T. J. Thomas
Eccles	L. & C.	T. S. Picton.
Edinburgh, N.B.	S.	J. Massie.
Elgin, N.B.	S.	A. A. Turriff.
Enfield	H.	R. Collins.
Enniskillen (County)	I.	J. P. Burkitt.
Epsom	H.	E. R. Capon.
Erdington	M.	H. H. Humphries.
Erith	H.	H. Hind.
Eston	Y.	C. McDermid.
Eton (Rural)	H.	R. Hallam.
" " (Highways)	H.	A. Gladwell.
Exeter	West.	T. Moulding.
Exmouth	West.	S. Hutton.
Falmouth	West.	W. H. Tressider.
Falkirk, N.B.	S.	D. Ronald.
Fareham	H.	W Butler.
Farnborough	H.	J. E. Hargreaves.
Farnham	H.	R. W. Cass.
Faversham	H.	S. P. Andrews.
Feltham	H.	R. T. Stewart.
Fenny Stratford	H.	J. Chadwick.
Finchley	H.	C. J. Jenkin.
Finsbury	Met.	P. G. Killick.
Flintshire (County)	W.N.	S. Evans.
Folkestone	H.	A. E. Nichols.
Foot's Cray	H.	W. A. Farnham.
Friern Barnet	H.	E. J. Reynolds.
Frimley	H.	T. C. Jones.
Frinton-on-Sea	E.	E. M. Bate.
Frome	West.	F. W. Jones.
Gainsborough	E.	S. W. Parker.
Gateshead	N.	N. P. Pattinson.
Gillingham	H.	J. L. Redfern.
Glamorgan (County)	W.S.	G. A. Phillips.
Glasgow, N.B.	S.	A. B. McDonald.
Glasgow, N B.	S.	T. Nisbet.
Glastonbury	West.	G. Alves.
Gloucester	West.	R. Read.
Gloucestershire	West.	E. S. Sinnott.
Glyncorrwg	W S.	W. P. Jones.
Godalming	H.	J. H. Norris.
Godstone (Rural)	H.	J. George-Powell.
Goole	Y.	E. H. Barber.
Gorton	L. & C.	J. W. Wiles.
Gosforth	N.	G. Nelson
Gosport and Alverstoke	H.	H. Frost.
Govan, N.B.	S.	F. G. Holmes.
Grantham	E.	W. Shackleton.
Gravesend	H.	F. T. Grant.
Grays Thurrock	H.	A. C. James.
Great Crosby	L. & C.	W. Hall.
Great Grimsby	E.	H. G. Whyatt.
Great Yarmouth	E.	J. W. Cockrill.
Greenock, N.B.	S.	A. J. Turnbull.
Grey County, New Zealand	A.	J. Higgins.
Greymouth, New Zealand	A.	E. I. Lord.

TOWN.	DISTRICT.	NAME.
Guernsey	H.	T. J. Guilbert
Guildford	H.	C. G. Mason.
„ (Rural)	H.	J. Anstee.
Hackney	Met.	N. Scorgie.
Hadham and Stansted	H.	E. T. Watts.
Halifax (Rural)	Y.	F. Gordon.
Hamilton, N.B.	S.	W. H. Purdie.
Hamilton, N.Z.	A.	S. B. Sims.
Hammersmith	Met.	H. Mair.
Hampstead	Met.	O. E. Winter.
Hampton-on-Thames	H.	S. H. Chambers.
Hampton Wick	H.	P. Taylor.
Handsworth	M.	H. Richardson.
Hanley	M.	J. Lobley.
Hants (County)	H.	W. J. Taylor.
Hanwell	H.	S. W. J. Barnes.
Harrow	H.	J. P. Bennetts.
Harwich	E.	H. Ditcham.
Haslingden	L. & C.	J. S. Green.
Hastings	H.	P. H. Palmer.
Hawick, N.B.	S.	Chas. Brown.
Hayes	H.	C. C. Gray.
Heckmondwike	Y.	J. Saville.
Helensburgh, N.B.	S.	J. R. Wilson.
Hemel Hempstead	M.	W. R. Locke.
Hendon	H.	S. S. Grimley.
„ (Rural)	H.	J. A. Webb.
Hengoed (Rural)	W.S.	J. P. Jones.
Hereford	M.	J. Parker.
„ (County)	M.	G. H. Jack.
Herne Bay	H.	F. W. J. Palmer.
Hertford	H.	J. H. Jevons.
Hertfordshire (Highways)	H.	E. Parry.
Heston and Isleworth	H.	J. G. Carey.
Heysham	L. & C.	H. Miller.
Heywood	L. & C.	J. A. Settle.
High Wycombe	H.	T. J. Rushbrooke.
Hinckley	M.	E. H. Crump.
Hitchin	H.	A. T. Blood.
Holborn	Met.	E. F. Spurrell.
Holland (County)	E.	T. J. Peacock.
Holyhead	W.N.	A. Asquith.
Hornsea	Y.	W. E. Warburton.
Hornsey	H.	E. J. Lovegrove.
Horsforth	Y.	R. R. Jones.
Horsham	H.	R. Renwick.
Hove	H.	H. H. Scott.
Howrah, Bengal	Ind.	A. Hale.
Hoylake and West Kirby	L. & C.	R. W. Fraser.
Huddersfield	Y.	K. F. Campbell.
„ (Gas)	Y.	E. A. Harman.
Hull	Y.	A. E. White.
Huntingdon (County)	M.	H. J. G. Leete.
Hyde	L. & C.	J. Mitchell.
Hythe	H.	Chris. Jones.
Ilford	E.	H. Shaw.
Ilfracombe	West.	O. M. Prouse.
Inglewood, N.Z.	A.	L. G. P. Spencer.

TOWN.	DISTRICT.	NAME.
Inverness	S.	T. H. Scott.
Ipswich	E.	E. Buckham.
Irlam	L. & C.	G. H. Kay.
Isle of Ely, North (County) ..	E.	H. F. Simpson.
Isle of Thanet (Rural)	H.	G. L. Butterworth.
Isle of Wight (Rural) (Highways)	H.	H. B. Cullin.
Islington	Met.	J. P. Barber.
Johannesburg	Af.	A. P. Lambert.
Kearsley	L. & C.	H. Nuttall.
Keighley	Y.	W. Fowlds.
Kenilworth	M.	S. Douglas.
Kensington	Met.	A. R. Finch.
Kent (County)	H.	H. P. Maybury.
Kesteven (County)	E.	W. B. Purser.
Keswick	N.	W. Hodgson.
Kettering	M.	T. R. Smith.
Keynsham (Rural)	West.	H. M. Bennett.
Kidderminster (Rural)	M.	G. J. Shepherd.
Kilkenny (County)	I.	A. M. Burden.
Kilmarnock, N.B.	S.	R. Blackwood.
King's Lynn	E.	J. H. Webb.
King's Norton	M.	A. W. Cross.
Kingston, Jamaica	A.	C. V. Abrahams.
Kingston-on-Thames	H.	R. H. Clucas.
King Williamstown, S.A.	Af.	J. Maden.
Kirkcaldy	S.	J. L. Lumsden.
Kirriemuir, N.B.	S.	J. S. Bruce.
Kroonstad, O.R.C.	Af.	F. Brown.
Krugersdorp, Transvaal	Af.	R. A. Webster.
Lagos	Af.	I. T. Hawkins.
Lambeth	Met.	H. C. J. Edwards.
Lanark (County)	S.	W. L. Douglass.
Lancashire (County)	L. & C.	W. H. Schofield.
Lancaster	L. & C.	J. C. Mount.
Lanchester (Rural) (Highways)	N.	W. Cumming.
Leatherhead	H.	J. E. Smales.
Leeds	Y.	W. T. Lancashire.
Leeds (Sewerage)	Y.	G. A. Hart.
Leek	M.	W. E. Beacham.
Leicester	M.	E. G. Mawbey.
" (County)	M.	S. P. Pick.
Leigh	L. & C.	T. Hunter.
" (Rural)	L. & C.	T. W. B. Gent.
Leigh-on-Sea	E.	J. W. Liversedge.
Leighton Buzzard	H.	C. H. Waithman.
Leith, N.B.	S.	J. R. Findlay.
Leitrim (County)	I.	E. O'N. Clarke.
Levenshulme	L. & C.	J. Jepson.
Lewisham	Met.	E. Van Putten.
Leyland	L. & C.	W. H. Wilkinson.
Lichfield	M.	W. B. Chancellor.
Limehurst (Rural)	L. & C.	H. H. Turner.
Limerick (County)	I.	J. Horan.
Lincoln	E.	R. A. MacBrair.

TOWN.	DISTRICT.	NAME.
LINCOLN (County)	E.	J. Thropp.
LINLITHGOW (Highways)	S.	A. Forbes.
LITHERLAND	L. & C.	A. H. Carter.
LITTLEBOROUGH	L. & C.	G. H. Wild.
LITTLEHAMPTON	H.	H. Howard.
LITTLE WOOLTON	L. & C.	R. Simmons.
LIVERPOOL	L. & C.	J. A. Brodie.
LLANDUDNO	W.N.	E. P. Stephenson.
LLANELLY	W.S.	G. Watkeys.
LLANTRISSANT (Rural)	W.S.	G. S. Morgan.
LOFTUS	Y.	T. H. Tarbit.
LONDON	Met.	F. Sumner.
„ (County)	Met.	M. Fitzmaurice.
LONDONDERRY	I.	W. J. Robinson.
LONDONDERRY (County)	I.	C. L. Boddie.
LONGFORD (County)	I.	J. W. Gunnis.
LONGTON	M.	J. W. Wardle.
LOUGHBOROUGH	M.	A. H. Walker.
LOUTH (County)	I.	P. J. Lynam.
LOWER BEBINGTON	L. & C.	H. W. Corrie.
LOWER HUTT, N.Z.	A.	T. Ward.
LOWESTOFT	E.	G. H. Hamby.
LUCKNOW (United Provinces)	Ind.	H. Lane Brown.
LUDLOW	West.	J. A. Spreckley.
LURGAN	I.	H. Shillington.
LUTON	M.	S. F. L. Fox.
LYMINGTON	H.	F. H. Parr.
LYTHAM	L. & C.	A. J. Price.
MACCLESFIELD (Rural)	L. & C.	J. Thorpe.
MAESTEG	W.S.	J. Humphreys.
MAIDSTONE	H.	T. F. Bunting.
MALDEN	H.	R. H. Jeffes.
MALDON	E.	T. R. Swales.
MALVERN	M.	W. O. Thorp.
MANCHESTER	L. & C.	T. De C. Meade.
MANSFIELD WOODHOUSE	M.	F. P. Cook.
MARGAM, PORT TALBOT	W.S.	J. Cox.
MARGATE	H.	E. A. Borg.
MARKET HARBOROUGH	M.	H. G. Coales.
MARPLE	L. & C.	D. J. Diver.
MARYLEBONE	Met.	J. A. P. Waddington.
MATLOCK	M.	J. Diggle.
MATLOCK BATH	M.	W. Jaffrey.
MAXWELLTOWN, N.B.	S.	J. McL. Bowie.
MELFORD (Rural)	E.	W. Carver.
MELTON MOWBRAY	M.	E. Jeeves.
MERTHYR TYDVIL	W.S.	T. F. Harvey.
MERTON	H.	G. Jerram.
METHLEY	Y.	T. W. Nichols.
MEXBOROUGH	Y.	G. F. Carter.
MIDDLESBROUGH	Y.	F. Baker.
MIDDLESEX (County)	H.	H. T. Wakelam.
MIDDLETON	L. & C.	W. Welburn.
MIDHURST (Rural)	H.	A. G. Gibbs.
MIDSOMER NORTON	West.	C. H. Sunderland.
MILTON-NEXT-SITTINGBOURNE	H.	W. R. Warlow.
MINEHEAD	West.	J. H. Wooton-Smith.

TOWN.	DISTRICT.	NAME.
MONMOUTH	West.	G. F. Grimwood.
MONMOUTHSHIRE (County)	West.	W. Tanner.
MONTGOMERY	W.N.	W. P. Hole.
MONTROSE, N.B.	S.	S. L. Christie.
MORLEY	Y.	W. E. Putman.
MUSSELBURGH, N.B.	S.	G. Landale.
NANTYGLO AND BLAINA	West.	W. J. Davies.
NEATH	W.S.	D. M. Jenkins.
„ (Rural)	W.S.	W. E. C. Thomas.
NELSON	L. & C.	B. Ball.
NESTON	L. & C.	C. E. Senior.
NEW MALDEN	H.	T. B Simmonds.
NEW MILLS	L. & C.	W. C. Sheard.
NEW SWINDON	H.	H. J. Hamp.
NEWARK	M.	G. Sheppard.
„ (Rural)	M.	R. Oakden.
NEWBURN-ON-TYNE	N.	T. Gregory.
NEWBURY	H.	S. J. L. Vincent.
NEWCASTLE-ON-TYNE	N.	C. R. S. Kirkpatrick.
NEWHAVEN	H.	F. J. Rayner.
NEWMARKET	E.	C. H. Waithman.
NEWPORT, MON.	West.	R. H. Haynes.
NEWRY	I.	C. Blaney.
NEWTOWN ST. BOSWELLS, N.B. ..	S.	G. Monteath.
NORTH SYDNEY, N.S.W.	A.	T. W. Seaver.
NORTHAMPTON	M.	A. Fidler.
NORTHUMBERLAND (County) ..	N.	J. A. Bean.
NORTHWICH	L. & C.	J. Brooke.
NORWICH	E.	A. E. Collins.
NOTTINGHAM	M.	A. Brown.
„ (County)	M.	E. P. Hooley.
NUNEATON	M.	F. C. Cook.
OAKHAM (Rural)	E.	C. W. Maudsley.
OAKWORTH	Y.	J. Spencer.
OGMORE AND GARRW	W.S.	H. D. Williams.
OLDBURY	M.	T. H. Shipton.
OSSETT	Y.	H. G. Keywood.
OSWESTRY	M.	G. W. Lacey.
OXFORD	H.	W. H. White.
OXFORDSHIRE (County)	H.	S. Stallard.
PADDINGTON	Met.	E. B. Newton.
PADIHAM	L. & C.	J. Gregson.
PAIGNTON	West.	C. O. Baines.
PAISLEY, N.B.	S.	J. Lee.
PARTICK, N.B.	S.	J. Bryce.
PEEBLES (County)	S.	R. S. Anderson.
PEMBERTON	L. & C.	G. Heaton.
PENANG, S. S.	A.	L. M. Bell.
PENARTH	W.S.	E. I. Evans.
PENGE	H.	H. W. Longdin.
PENRITH	N.	J. J. Knewstubb.
PENRYN	West.	J. P. Jenkins.

TOWN.	DISTRICT.	NAME.
Perth, N.B.	S.	R. McKillop.
Perth, West Australia	A.	H. T. Haynes.
Peterborough	M.	J. W. Walshaw.
Plymouth	West.	J. Paton.
Pollokshaws, N.B.	S.	D. Burns.
Pontardawe (Rural)	W.S.	J. Morgan.
Pontefract	Y.	J. E. Pickard.
Pontypridd	W.S.	P. R. A. Willoughby.
Poole	W.	S. J. Newman
Portadown	I.	W. Wilson.
Port Elizabeth, South Africa	Af.	A. S. Butterworth.
Port Glasgow, N.B.	S.	J. Murray.
Portishead	West.	F. H. Smith.
Portland	West.	R. S. Henshaw.
Portslade-by-Sea	H.	A. T. Allen.
Portsmouth	H.	P. Murch.
Prahran, Victoria	A.	W. Calder.
Queen's County	I.	H. V. White.
Queenstown, South Africa	Af.	W. A. Palliser.
Ramsbottom	L. & C.	T. H. Bell.
Ramsgate	H.	T. G. Taylor.
Rangoon	A.	L. P. Marshall.
Rawmarsh	Y.	J. Bourne.
Rawtenstall	L. & C.	J. Johnston.
Redcar	Y.	J. Howcroft.
Redditch	M.	A. J. Dickinson.
Reigate	H.	F. T. Clayton.
Renfrewshire (County), N.B.	S.	J. Murray.
Retford	M.	J. D. Kennedy.
Rhondda	W.S.	W. J. Jones.
Rhymney	West.	W. L. Marks.
Richmond, Surrey	H.	J. H. Brierley.
Richmond, Yorks	Y.	T. H. Hailstone.
Rochdale	L. & C.	S. S. Platt.
Rochester	H.	W. Banks.
Rochford (Rural)	H.	H. T. Sidwell.
Rotherham	Y.	E. B. Martin.
Rowley Regis	M.	W. H. Brettell.
Rugeley	M.	W. E. Rogers.
Runcorn	L. & C.	J. Wilding.
,, (Rural)	L. & C.	W. Diggle.
Rushden	M.	W. B. Madin.
Rutherglen, N.B.	S.	S. McBride.
Rutland (County)	E.	J. Richardson.
Ryton-on-Tyne	N.	J. P. Dalton.
Saffron Walden	E.	A. H. Forbes
St. Albans	H.	G. Ford.
St. Andrews, N.B.	S.	W. Watson.
St. Pancras	Met.	W. N. Blair.
Sale	L. & C.	W. Holt.
Saltburn-by-the-Sea	Y.	G. S. L. Bains.

TOWN.	DISTRICT.	NAME.
Scarborough	Y.	H. W. Smith.
„ (Rural)	Y.	J. A. Iveson
Sedgfield, Co. Durham	N.	J. Stones.
Selkirk, N.B.	S.	J. Pritty.
Sevenoaks	H.	S. Towlson.
Shanghai, China	A.	C. Mayne.
Shanklin	H.	E. C. Cooper.
Sheffield	Y.	C. F. Wike.
Shepton Mallet	West.	D. Hinchcliff.
Sheringham	E.	F. Hall Smith.
Shrewsbury	M.	W. C. Eddowes.
Shropshire (County)	M.	A. T. Davis.
Singapore	A	R. Peirce.
Skelton-in-Cleveland	Y.	W. P. Robinson.
Skipton (Rural)	Y.	A. Rodwell.
Slough	H.	W. W. Cooper.
Smallthorne	M.	J. Deane.
Smethwick	M.	C. J. Fox-Allin.
Solihull (Rural)	M.	A. E. Currall.
Soothill Upper	Y.	J. Blackburn.
South Shields	N.	S. E. Burgess.
„ „ (Rural)	N.	T. T. Bains.
Southall Norwood	H.	R. Brown.
Southampton	H.	J. A. Crowther.
Southend-on-Sea	H.	E. J. Elford.
Southgate	H.	C. G. Lawson.
Southport	L. & C.	R. P. Hirst.
Southwark	Met.	A. Harrison.
Southwick	H.	G. W. Warr.
Southwick-on-Wear	N.	W. B. Thomas.
Spilsby (Rural)	E.	T. A. Busbridge.
Stafford	M.	W. Blackshaw.
„ (County) (Highways) ..	M.	J. Moncur.
Staines	H.	E. J. Barrett.
„ (Rural)	H.	G. W. Manning.
Stalybridge	L. & C.	J. N. White.
Stamford	E.	F. R. Ryman.
Stepney	Met.	M. W. Jameson.
Stirling	S.	A. H. Goudie.
Stockport	L. & C.	J. Atkinson.
Stockton-on-Tees	N.	M. H. Sykes.
Stoke-on-Trent	M.	A. Burton.
Stoke Newington	Met.	W. F. Loveday.
Stone	M.	A. R. Ridout.
Stourbridge	M.	F. Woodward.
Stratford-on-Avon	M.	R. Dixon.
Stretford	L. & C.	E. Worrall.
Stroud	West.	G. P. Milnes.
Sudbury	E.	W. I. Tait
Suffolk (County), East	E.	H. Miller.
Sunbury-on-Thames	H.	H. F. Coales.
Sunderland (Rural)	N.	T. Young.
Surbiton	H.	H. T. Mather.
Surrey (County)	H.	F. G. Howell.
Sussex (County), East	H.	F. J. Wood.
„ „ West	H.	H. W. Bowen.
Sutherland, N.B. (County) ..	S.	J. M. MacGregor.
Sutton	H.	C. C. Smith
Sutton Coldfield	M.	W. A. H. Clarry.
Sutton-in-Ashfield	M.	W. Burn.

TOWN.	DISTRICT.	NAME.
SWADLINCOTE	M.	T. Kidd.
SWANAGE	West.	J. S. Senior.
SWANSEA	W.S.	G. Bell.
" (Rural)	W.S.	T. T. Williams.
SWINTON	L. & C.	H. Entwisle.
SYDNEY, NEW SOUTH WALES	A.	J. M. Smail.
TADCASTER (Rural)	Y.	T. Scott.
TAMWORTH	M.	F. E. G. Bradshaw.
" (Rural)	M.	H. J. Clarson.
TANFIELD	N.	R. Heslop.
TAUNTON (Rural)	West.	T. Goldsworthy-Crump.
TAVISTOCK	West.	W. G. Lane.
TEDDINGTON	H.	M. Hainsworth.
TEIGNMOUTH	West.	C. F. Gettings.
TENBURY (Rural)	M.	R. W. Jarvis.
TEWKESBURY	West.	W. Ridler.
THORNHILL	Y.	A. Rothera.
TIENTSIN, CHINA	A.	A.W.H. Bellingham.
TIPPERARY (County), South	I.	E. A. Hackett.
TIPTON	M.	W. H. Jukes.
TIVERTON	West.	J. Siddalls.
TODMORDEN	Y.	J. A. Heap.
TOKIO, JAPAN	A.	B. Kusakabe.
TONBRIDGE	H.	W. L. Bradley.
" (Rural)	H.	F. Harris.
TOOWONG, QUEENSLAND	A.	W. E. Irving.
TOOWOOMBA, QUEENSLAND	A.	J. C. Ross.
TOTTENHAM	H.	W. H. Prescott.
TOTTINGTON	L. & C.	L. Kenyon.
TOWYN	W.N.	R. P. Morgan.
TROWBRIDGE	West.	H. G. N. Lailey.
TRURO	West.	M. Lea.
TUNBRIDGE WELLS	H.	W. H. Maxwell.
TUNSTALL	M.	A. R. Wood.
TURTON	L. & C.	V. Laithwaite.
TWICKENHAM	H.	F. W. Pearce.
TYLDESLEY	L. & C.	J. B. Smith.
TYNEMOUTH	N.	J. F. Smillie.
TYRONE (County), North	I.	F. J. Lynam.
" " South	I.	J. W. Leebody.
URMSTON	L. & C.	J. Heath.
UXBRIDGE (Rural) (Highways)	H.	E. Birks.
" (Rural)	H.	J. F. Stow.
VENTNOR	H.	H. H. Oakes.
WAKEFIELD	Y.	R. Porter.
" (Rural)	Y.	F. Massie.
WALLASEY	L. & C.	W. H. Travers.
WALMER	H.	H. W. Barker.
WALSALL	M.	J. Taylor.
WALSALL (Rural)	M.	W. P. Young.
WALTHAM CROSS	E.	W. T. Streather.
WALTHAMSTOW	H.	E. Morley.

TOWN.	DISTRICT.	NAME.
WALTHAMSTOW	H.	G. W. Holmes.
WANDSWORTH	Met.	P. Dodd.
WANSTEAD	H.	J. T. Bressey.
WANTAGE	H.	W. Hanson.
WARE	H.	H. F. Hill.
WARMINSTER	West.	C. H. Lawton.
WARWICKSHIRE (County)	M.	J. Willmot.
WATERFORD	I.	M. J. Fleming.
„ (County)	I.	W. E. L. Duffin.
WATERLOO	L. & C.	F. S. Yates.
WATFORD	H.	D. Waterhouse.
WATH-UPON-DEARNE	Y.	H. C. Poole.
WEALDSTONE	H.	H. Walker.
WELLINGBOROUGH	M.	E. Y. Harrison.
WEMBLEY	H.	C. R. W. Chapman.
WEST BROMWICH	M.	A. D. Greatorex.
WEST HARTLEPOOL	N.	N. F. Dennis.
WEST MALLING (Rural)	H.	J. Marshall.
WESTMINSTER	Met.	J. W. Bradl
WEYMOUTH AND MELCOMBE REGIS	West.	W. B. Morgan.
WHITCHURCH	M.	M. Sowden.
WHITEHAVEN	N.	E. E. Stiven.
WICKLOW	I.	J. Pansing.
WIDNES	L. & C.	J. S. Sinclair.
WIGSTON MAGNA	E.	W. J. G. Clark.
WILLENHALL	M.	T. E. Fellows.
WILLESDEN	H.	O. C. Robson.
WILLINGTON QUAY	N.	J. F. Davidson.
WILMSLOW	L. & C.	A. S. Cartwright.
WILTS (County)	West.	A. Dryland.
WIMBLEDON	H.	C. H. Cooper.
WINCHESTER	H.	W. V. Anderson.
„ (Rural)	H	G. E. Carter.
WINDERMERE	L. & C.	C. E. Hines.
WINDSOR	H.	E. A. Stickland.
WISBECH	E.	K. J. S. Harris.
WOKINGHAM	M.	C. W. Marks.
WOLVERHAMPTON	M.	G. Green.
WOMBWELL	Y.	J. W. Harrison.
WOOD GREEN	H.	C. J. Gunyon.
WOODFORD	E.	W. Farrington.
WOOLWICH	Met.	J. R. Dixon.
WORCESTER	M.	T. Caink.
„ (County)	M.	J. H. Garrett.
WORKSOP	M.	G. Rawson.
WORTHING	H.	F. Roberts.
WORTLEY (Rural)	Y.	G. E. Beaumont.
WREXHAM	W.N.	J. England.
„ (Rural)	W.N.	J. P. Evans.
WROTHAM	H.	F. T. Elliott.
YOKOHAMA, JAPAN	A.	R. Hara.
YORK	Y.	F. W. Spurr.
YORKSHIRE, East Riding	Y.	A. Beaumont.
„ North Riding	Y.	W. G. Bryning.

ASSOCIATES.

** Those Associates against whose names a star is placed have passed the examination and hold the Testamur of the Association.*

G *signifies elected as Graduate.*
TA *transferred to Associate.*

Date of Election and Transfer.		
1907 Jan. 19	*Aldridge, A. E. W.	Assistant Borough Surveyor, Walsall.
1906 June 28	*Ash, H. J.	Chief Engineering Assistant, Council Offices, Nuneaton.
1901 Oct. 19	Ashbee, W.	Divisional Surveyor, Middlesex C.C. Briarside, Hanwell, W.
1908 June 25	*Baggott, S. O.	Borough Engineer's Office, Northampton.
1906 May 26	*Ballard, W. E., A. M. Inst. C.E.	Assistant Engineer, Council Offices, King's Heath, near Birmingham.
1907 May 25	Baxter, J. G. R.	Borough Engineer's Office, Great Grimsby.
1904 Sept. 17	Bell, C. D., B.Sc. (*Vict.*) ..	Borough Engineer's Office, Barrow-in-Furness.
G1906 Dec. 15 TA1908 Feb. 29	*Bell, G. H.	Borough Surveyor's Office, Swansea.
G1897 July 31 TA1901 Oct. 19	*Bentley, J. H., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Oldham.
G1893 June 24 TA1902 Nov. 8	*Birch, J.	Deputy Surveyor, Public Offices, East Ham.
G1900 June 16 TA1908 June 25	*Blakeway-Phillips, R. ..	City Engineer's Office, Westminster, S.W.
1903 Jan. 17	*Booth, E. W., A. M. Inst. C.E.	Engineering Assistant, Town Hall, Croydon.
G1905 Jan. 28 TA1907 Mar. 2	*Bradley, C. G.	Town Surveyor, Goole.
G1899 June 10 TA1905 Jan. 28	*Bradshaw, A. S., A.M. Inst. C.E.	Deputy Borough Engineer, Bedford.
G1898 June 30 TA1903 June 25	*Briscoe, J. T.	Deputy Engineer, Council Offices, Enfield.
1903 July 25	*Bromly, A., A.M. Inst. C.E.	Assistant Engineer, Town Hall, Croydon.
1902 Jan. 25	Brookes, A. E.	County Surveyor, Western Division, Cornwall, St. Ives.
1902 Jan. 25	Brown, H. A.	Assistant Borough Surveyor, Town Hall, Fulham, S.W.
1908 June 25	*Brown, H. B. E.	Borough Engineer's Office, Northampton.
G1905 May 27 TA1908 July 18	*Bull, E. M.	Council Offices, Finchley.
1908 Feb. 29	*Bullough, J. S.	Borough Engineer's Office, Blackburn.

Date of Election and Transfer.		
1904 May 28	*BURTON, W. E. H., Assoc. M. Inst. C.E.	Chief Engineering Assistant, County Architect's Office, Wakefield.
1904 Sept. 1	CARSON, W. H., Assoc. M. Inst. C.E.	City Engineer's Office, City Hall, Ottawa, Canada.
1904 May 28	CARTER, E. W. A...	Assistant City Surveyor, Guildhall, Gloucester.
G1903 Dec. 12 TA1907 Mar. 2	*CARTER, S. F. R.	Assistant Engineer, Heston & Isleworth Urban District Council.Town Hall,Hounslow.
G1890 Sept. 13 TA1902 Sept. 6	*CATCHPOLE, H.	Deputy Engineer, Council Offices, Finchley.
1908 Feb. 29	CLARE, T. A...	Borough Engineer's Office, Leigh, Lancs.
G1894 July 7 TA1904 Sept. 17	*CLAYPOOLE, A. H., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
1904 Oct. 11	CONNOR, C.	c/o John Mowlem & Co., Grosvenor Wharf, S.W.
1903 May 16	COOKE, J. E.	Assistant Borough Engineer, Town Hall, Islington.
G1900 May 19 TA1901 Oct. 19	*COOMBS, C. A.	Irrigation Works, Trincomalee, Ceylon, India.
1907 Sept. 7	COURT, W. H. A., A. M. Inst. C.E.	Borough Surveyor's Office, Leicester.
G1899 Oct. 21 TA1902 Nov. 8	*COWAN, G.	District Surveyor, Town Hall, Portsmouth.
G1901 Aug. 24 TA1901 Oct. 19	*COX, A. L., A.M.Inst.C.E. ..	City Surveyor's Office, Manchester.
1905 Mar. 4	*COX, C. L., A.M.Inst.C.E. ..	Assistant Engineer, Municipal Offices, Colombo.
G1906 Jan. 20 TA1907 Mar. 2	*CRABB, H. R., A.M.Inst.C.E. ..	District Surveyor, Council House, Birmingham.
G1905 June 22 TA1906 Nov. 3	*CROSS, W. G.	Assistant Borough Surveyor, Tunbridge Wells.
1901 Oct. 19	*CROXFORD, C. H.	Chief Engineering Assistant, Town Hall, Wood Green, N.
G1906 Jan. 20 TA1908 Apr. 25	*DARBY, H.	Town Hall, Ealing, W.
G1903 Dec. 12 TA1905 May 27	*DEBNEY, W., A.M. Inst. C.E.	Borough Engineer's Office, Birkenhead.
1904 Aug. 19	DE KRETSER, H. K.	District Engineer, P. W. D., Mihintale, Anuradhapura, Ceylon.
1904 Aug. 12	DONALD, R. B., A.M.Inst.C.E.	Resident Engineer's Office, Sewage Disposal Works, Huddersfield.
1906 June 28	*DRESDEN, W. J.	Chief Engineering Assistant, Town Hall, Battersea.
1907 Jan. 19	*DUNNING, W. J.	Assistant Surveyor, Council Offices, Colwyn Bay.
G1899 June 29 TA1905 June 22	*DYER, R. H.	Assistant Borough Engineer, Southend-on-Sea.

Date of Election and Transfer.		
G1898 Dec. 17 TA1901 Dec. 7	*Ellison, D., A.M.Inst.C.E.	Deputy Borough Engineer, West Bromwich.
G1898 Feb. 19 TA1902 Jan. 25	*Endsor, H. A.	Surveyor, Rural District Council, Keynsham, Bristol.
1904 Aug. 27	Forbes, W.	Burgh Engineer's Office, Edinburgh, N.B.
G1899 Oct. 21 TA1903 July 25	*Foster, H. H.	Assistant Surveyor, Borough Surveyor's Office, Wandsworth. 215 High Rd., Balham.
G1901 May 11 TA1902 Jan. 25	*Gair, J.	Assistant Borough Surveyor, Town Hall, Hammersmith, W.
P1903 Mar. 21	Galbraith, A. R., A.M.Inst. C.E.I.	District Surveyor, Town Hall, Portsmouth.
1905 June 22	*Gammage, E. J.	Borough Surveyor's Office, Dudley.
1905 June 22	*Goode, W. J.	Divisional Surveyor, Shropshire. Wellington, Salop.
G1899 Dec. 16 TA1902 May 10	*Goodfellow, H., A.M.Inst. C.E.	Chief Engineering Assistant, Town Hall, Southport.
G1894 Jan. 13 TA1902 July 10	*Gordon, J., A.M. Inst. C.E.	Assistant Burgh Surveyor, Aberdeen, N.B.
1903 July 25	Gray, A. R.	Engineering Assistant, Council House, Birmingham.
G1893 Jan. 14 TA1901 Oct. 19	*Greenwood, J. P., A.M. Inst. C.E.	Deputy Borough Surveyor, Town Hall, Burnley.
1904 Aug. 9	Greig, J. M. M., A.M.Inst. C.E.	c/o Messrs. Kennedy, Ltd., Partick, Glasgow.
G1906 May 26 TA1908 June 25	*Griffiths, H.	Borough Surveyor's Office, Crewe.
1903 June 6	Harding, H. W.	Chief Engineering Assistant, City Engineer's Office, Bristol.
G1899 Oct. 21 TA1902 May 10	*Harper, A.	Deputy Borough Surveyor Town Hall, St. Helen's, Lancs.
1903 June 6	Heap, H., A.M. Inst. C.E. ..	16 Manor Avenue, Grimsby.
G1903 Jan. 17 TA1905 Apr. 29	*Heath, J. R.	Assistant Borough Surveyor, Burslem.
1904 Aug. 26	Henderson, R. T...	City Engineer's Office, City Chambers, Glasgow, N.B.
G1905 Dec. 9 TA1906 Dec. 15	*Hewitt, F.	Surveyor to the Urban District Council, Hoyland Nether.
G1900 Mar. 10 TA1902 May 10	*Hinchsliff, E. R...	Deputy Surveyor, Council Offices, Barry.
1905 Jan. 28	Hipwood, J. W., A. M. Inst. C.E.	Chief Assistant, Borough Eng. Office, Southend-on-Sea.
G1907 Mar. 2 TA1908 Apr. 25	*Hodge, A. C...	City Surveyor's Office, Sheffield.
G1900 Aug. 25 TA1902 Mar. 22	*Holloway, W. C.	Chief Engineering Assistant, Council Offices, Kettering.

Date of Election and Transfer.		
G1897 July 31 TA1902 Nov. 8	*JENKINS, R. J.	Chief Assistant, Town Hall, Portsmouth.
1902 May 10	KER, A. M., B. Sc. (*Vict.*), A.M. Inst. C.E.	Assistant Borough Engineer, Town Hall, Warrington.
G1896 June 25 TA1906 Dec. 15	*KIESER, W. H. G., Assoc. M. Inst. C.E.	District Surveyor, Bristol.
1906 Mar. 3	KINNEAR, C. F. A...	City Chambers, Edinburgh.
1904 Feb. 27	KIRBY, H. C.	Town Engineer's Department, Pretoria, S.A.
1901 Dec. 7	LASHMORE, E. W., Assoc. M. Inst. C.E.	District Surveyor, Alma Vale Road, Clifton, Bristol.
G1903 June 25 TA1906 Dec. 15	*LEES, H. B.	District Eng., Jaffna, Ceylon.
1907 Sept. 7	LILLEY, A. S.	Surveyor to the Urban District Council, Porthcawl, Glam.
1904 Sept. 6	McINNES, D.	City Engineer's Office, Glasgow, N.B.
1902 Nov. 8	McKENZIE, L. S., A.M.Inst.C.E.	District Surveyor, 63 Queen Square, Bristol.
G1896 Dec. 15 TA1907 Nov. 2	*MACKENZIE, W. H.	Assistant Borough Engineer, Bournemouth.
1903 Mar. 21	MANNING, W. R., A.M. Inst. C.E.	Assistant Borough Surveyor, Town Hall, Chelsea.
1904 Aug. 4	MARR, G. E.	District Offices, Hamilton, N.B.
G1905 Jan. 28 TA1907 June 20	*MATHEW, H. B., A.M.Inst. C.E.	Chief Assistant, Borough Engineer's Office, Dover.
G1906 May 26 TA1908 June 25	*MILNER, J. D., A.M.Inst.C.E.	City Engineer's Office, Hull.
G1898 Dec. 17 TA1901 Oct. 19	*MITCHELL, G.	Waterworks Engineer's Office, Lincoln.
1904 Sept. 19	MORRISON, A. W.	Burgh Engineer's Office, Edinburgh, N.B.
G1902 July 10 TA1907 Jan. 19	*NATHANIELSZ, A. H., Assoc. M. Inst.C.E.	District Engineer, P.W.D., Bungalow, Wegambo, Ceylon.
G1901 Aug. 24 TA1902 Nov. 8	*NEAVE, J.	Chief Assistant, Engineer's Department, Town Hall, Walthamstow.
G1906 Jan. 20 TA1907 Nov. 2	*NEWMAN, W. W.	Assistant Engineer, Urban District Council, Watford.
1904 Aug. 17	OLIVER, J. R...	Burgh Engineer's Department, Edinburgh, N.B.
G1895 June 27 TA1902 July 10	*OPENSHAW, J., A.M.Inst.C.E.	Engineering Assistant, Town Hall, Salford.
G1902 Mar. 22 TA1904 Oct. 29	*PARR, J. E., A.M.Inst.C.E. ..	Chief Assistant, Engineer's Office, Handsworth, Birmingham.

Date of Election and Transfer.		
1904 Sept. 5	PATERSON, J. B.	Deputy Burgh Surveyor, Partick, N.B.
G1900 June 16 TA1902 Feb. 22	*PERCIVAL, W.	Assistant Borough Surveyor, Court House, Longton, Staffs.
1906 Jan. 20	*PERKINS, G. S.	Assistant Surveyor to the Urban District Council, Teddington.
G1895 Jan. 19 TA1901 Oct. 19	*PERKINS, J.	Engineering Assistant, Council House, Birmingham.
1903 Dec. 12	*RACE, A...	Chief Assistant, Borough Engineer's Office, Barrow-in-Furness.
1904 Aug. 31	REID, M...	Burgh Engineer's Office, Paisley, N.B.
G1899 Mar. 25 TA1907 Jan. 19	*RICHARDS, E. P.	Engineer's Office, Derwent Valley Water Board, Bamford, *viâ* Sheffield.
1906 May 26	ROBINSON, W. P., B.Sc.(Vict.) A.M.Inst.C.E.	Shire Hall, Durham.
1902 Nov. 8	ROWBOTTOM, J.	Chief Assistant, Borough Surveyor's Office, Ashton-under-Lyne.
1903 June 6	SADLER, F.	Deputy Surveyor, Council Offices, Acton, W.
G1894 Oct. 20 TA1902 May 10	*SAVAGE, E. B., A.M.Inst. C.E.	Superintending Engineer, Sewers & Rivers Department, Council House, Birmingham.
1904 May 28	*SMITH, C. P.	Assistant Borough Engineer, Town Hall, Greenwich.
1906 Apr. 28	SMITH, H. J. T., A.M.Inst. C.E.	Assistant Engineer, Municipal Offices, Calcutta.
1904 Aug. 22	STEPHEN, T. M.	District Offices, Hamilton, N.B.
1904 Apr. 30	STORY, G. E.	Surveyor, Western District, Town Hall, Sheffield.
1903 Mar. 21	SUTCLIFFE, H.	Deputy Borough Engineer Town Hall, Huddersfield.
G1899 June 10 TA1905 Sep. 23	*THACKERAY, J. R...	Deputy Borough Surveyor, Eastbourne.
G1907 June 20 TA1907 Nov. 2	*THACKRAY, F. J.	Engineering Assistant, Rural District Council, Burnley.
1904 June 25	*THOMPSON, W., A.M.Inst.C.E.	Deputy Borough Engineer, Burton-on-Trent.
1905 Sep. 23	WARD, A. W., A.M. Inst. C.E.	Assistant Borough Surveyor, Stockport.
G1899 June 10 TA1902 Mar. 22	*WEIR, J. S., A.M. Inst. C.E.	Borough Engineer, Jarrow.
G1902 July 10 TA1905 Jan. 28	*WHITAKER, G. H., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Sunderland.

Date of Election and Transfer.		
1903 May 16	WHITE, W. H. J., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Cheltenham.
G1902 Nov. 8 TA1904 Feb. 27	*WIBBERLEY, J., A.M.Inst.C.E.	Engineering Assistant, Municipal Offices, Plymouth.
G1901 Aug. 24 TA1907 Nov. 2	*WILKINSON, H. F., A.M.Inst. C.E.	Senior Engineering Assistant, Urban District Council, Tottenham.
1902 Mar. 22	WILLIAMS, H. B.	Chief Assistant, Borough Engineer's Office, Workington.
1902 July 10	WILLIAMS, J.	Assistant Borough Surveyor, Town Hall, Hampstead, N.W.
G1901 Dec. 7 TA1906 Dec. 15	*WILLIAMS, J. H.	Deputy Borough Engineer, Todmorden.
1906 Apr. 28	WILLIAMS, S. G., Assoc. M. Inst. C.E.	Assistant Engineer, Municipal Offices, Singapore, S.S.
G1898 June 30 TA1901 Dec. 7	*WILSON, F., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
G1891 Aug. 1 TA1901 Oct. 19	*YARWOOD, H.	Assistant Borough Surveyor, Town Hall, Rochdale.
G1901 June 8 TA1902 Feb. 22	*YELLAND, T.	Assistant Borough Engineer, Bury.

GRADUATES.

All Graduates have passed the examination and hold the Testamur of the Association.

Date of Election.		
1906 April 28	ANDREWS, S. H.	Hendon House, Limesford Road, Nunhead, S.E.
1893 Oct. 2	BALL, J. B., M. Inst. C.E. ..	Engineer's Office, G.C. Railway, Marylebone, N.W.
1905 June 22	BARKER, H. W.	Council House Handsworth, Birmingham.
1890 Mar. 29	BAYLEY, G. H., A.M.Inst.C.E.	19 Cooper Street, Manchester.
1897 July 31	BEARD, E. T., M. Inst. C.E...	Hill House, Walmer, Kent.
1906 June 28	BEAUMONT, R. H..	Greno Lodge, Grenoside, near Sheffield.
1906 May 26	BENTLEY, W...	468 St. Helens Road, Bolton, Lancs.
1902 Mar. 22	BERRINGTON, E. E. W... ..	28 Victoria Street, Westminster, S.W.
1903 Dec. 12	BIKER, W. J. E.	Municipal Offices, Harrogate.
1901 Aug. 24	BLANCHARD, R.	Town Hall, Leicester.
1889 June 8	BLIZARD, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
1892 Oct. 15	BRADSHAW, J. B., A.M.Inst. C.E.	Officers' Quarters, Library Street, Gibraltar.
1908 July 18	BROTHERS, L. D.	Borough Engineer's Office, Blackburn.
1896 June 25	BRUCE, W...	Burgh Engineer's Office, Edinburgh.
1889 July 4	BRYANS, J. G., A.M.Inst.C.E.	277 Calle 25 de Mayo, Buenos Aires.
1899 June 29	BURGESS, R. W.	Town Hall. Stratford, E.
1903 June 6	BUTLER, H. L.	18 Gayton Road, Hampstead.
1905 June 22	BUTLER, R.	"Woodthorpe," Prospect Road, Tunbridge Wells.
P1904 June 25	BUTT, E. E. W.	Council Offices, Birmingham.
1902 July 10	BUTTON, F. E.	City Surveyor's Office, Manchester.
1906 June 28	CAPLEN, L.	Rusthall, Tunbridge Wells.
1897 June 19	CARTLEDGE, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
1906 May 26	CASTLE, J. H...	27 Highbury Park, Highbury, N.
1906 Dec. 15	CATHCART, A. B., A.M.Inst. C.E.	c/o Water Engineer, St. Peter's Church Side, Nottingham.
1908 June 25	CHAPMAN, H. J.	31 Smisby Road, Ashby-de-la-Zouch.
1908 June 25	CHARLES, J. A.	Borough Engineer's Office, Barrow-in-Furness.
1904 Dec. 3	CLARKE, R. E.	Public Offices, Arnold, Notts.
1894 July 7	CLEGG, H., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Felixstowe.
1908 Dec. 12	COCHRANE, J...	15 Ure Place, Montrose Street, Glasgow.
1906 May 26	CONWAY, F. J. K.	Borough Engineer's Office, Town Hall, Birkenhead.
1906 Dec. 15	COUZENS, R. H.	City Engineer's Office, Carlisle.
1904 May 28	COWLISHAW, H. H.	108 Wellesley Road, Croydon.
1904 Jan. 23	COX, C. E.	Windmill Hill, Cradley. Cradley Heath.

Date of Election.		
1897 June 19	Cresswell, W. T.	11 Victoria Street, S.W.
1906 Sept. 22	Criswell, W.	Contractor's Office, Derwent Valley Waterworks, Bamford, Sheffield.
1892 July 11	Cross, F. W., A.M. Inst. C.E.	"Ingleside," Clifton Road, Sutton Coldfield.
1907 May 25	Crossley, H. B.	Town Hall, Richmond, Surrey.
1903 June 6	Cubitt, H. W.	County Hall, Spring Gardens, S.W.
1905 Jan. 28	Darby, A. E...	Town Hall, West Didsbury, Manchester.
1901 June 8	Davidge, W. R., Assoc. M. Inst. C.E.	District Surveyor, Lewisham (West), 301a Brockley Road, S.E.
1902 July 10	Dawkins, F.	Borough Surveyor's Office, Bournemouth.
1907 Nov. 2	de Colville, H. M.	Caxton House, Westminster, S.W.
1902 July 10	Deeley, G. P.	Moushall, Amblecote, Brierley Hill, Staffs.
1904 May 28	Draper, J.	Council House, Handsworth, Birmingham.
1903 Oct. 17	Duncan, L. G.	10 Hanover Buildings, Southampton.
1906 May 26	Eayrs, T. W., A.M.Inst.C.E.	"Thornlea," Beeches Road, West Bromwich.
1907 Sept. 7	Edwards, E. W.	Municipal Buildings, Pontypridd.
1906 Dec. 15	Edwards, J. H.	9 Talbot Road, Wrexham.
1898 Dec. 17	Essex, E. H., A.M. Inst. C.E.	Town Hall, Leyton, N.E.
1905 May 27	Farrar, W.	Town Hall, Todmorden.
1886 Sept. 11	Fenton, W. C.	10 Paradise Square, Sheffield.
1900 June 16	Fisher, R.	37 Inman Road, Harlesden, N.W.
1903 July 25	Ford, J...	Lower House, Branscombe, Axminster.
1903 Feb. 21	Foster, J. W.	Town Hall, Bradford.
1903 June 6	Foster, W. A., A.M.Inst.C.E.	Town Hall, Accrington.
1907 Dec. 14	Furness, D., Stud.Inst.C.E.	Town Hall, Blackpool.
1903 June 25	Gettings, S. S., Assoc. M. Inst. C.E.	Resident Engineer's Office, Tring, Herts.
1899 June 10	Gibson, W. S.	"Everitta," Finchley Lane, N.W.
1888 July 12	Glass, S. N., A.M. Inst. C.E.	16 Ravenscroft Road, Chiswick.
1905 Jan. 28	Goddard, F. B.	215 Balham High Road, Balham, S.W.
1906 Dec. 15	Goldsmith, W. H.	Town Hall, Hull.
1904 Dec. 3	Grove, A.	1 Parkfield Terrace, Stourbridge.
1905 June 22	Gunson, E., A.M. Inst. C.E.	c/o Grindlay & Co., Calcutta.
1905 June 22	Hadfield, J. R.	District Council Offices, Barnes.
1904 Jan. 23	Harkness, J.	20 Duke Street, Edinburgh.
1901 June 27	Harlow, W. W. R., Assoc. M. Inst. C.E.	City Engineer's Office, Carlisle.
1908 May 23	Harmer, E. F.	25 Mansion Road, Southampton.
1906 Mar. 3	Harrison, J.	355 Manchester Road, Burnley.
1903 June 25	Harrison, P. T.	Borough Engineer, Dorchester.
1907 Nov. 2	Harrison, W. A.	Edgerton House, Winewall, near Colne, Manchester.

Date of Election.		
1905 Oct. 28	HASSALL, J.	Resident Engineer's Office, Western Valleys (Mon.) Sewerage Board, Bassaleg, Mon.
1907 Mar. 2	HAZELTINE, C. A.	10 Summerhill Road, South Tottenham.
1908 Feb. 29	HEDGES, H. N.	55 Western Road, Tring.
1893 Jan. 14	HELLAWELL, O.	Town Hall, Withington, Manchester.
1906 June 28	HEWES, G. W.	27 Williams Road, Burnley.
1906 Dec. 15	HEWITT, A. C.	"Nutfield," Scarborough Road, Filey. Yorkshire.
1896 June 25	HILLS, O. C.	360 Mare Street, Hackney, N.E.
1900 June 16	HOBSON, E.	117 Oakland Road, Hillsborough, Sheffield.
1906 Mar. 3	HOLDEN, R. B.	Town Hall, Oldham.
1907 Dec. 14	HOLT, P., Stud.Inst.C.E.	Cloughfield, near Manchester.
1904 Oct. 29	HOWELL, H. H., A.M.Inst.C.E.	63 Queen Square, Bristol.
1903 Jan. 17	HOWELLS, D. P., A.M.Inst. C.E.	Municipal Engineer, Muizenberg, Cape Colony.
1907 May 25	HOYLE, J. A.	Borough Surveyor's Office, Haslingden.
1907 Jan. 19	HUNT, C. F.	Council Offices, Leigh-on-Sea, Essex.
1899 June 10	HUTCHINGS, W. A.	Springfield Brewery, Wolverhampton.
1904 Dec. 3	HUTCHINSON, H. F.	Engineer's Dept., Town Hall, Walthamstow.
1903 Dec. 12	JACQUES, H. S., A.M.Inst.C.E.	5 Radnor Road, Westbury-on-Trym.
1906 Dec. 15	JENKINSON, F. O.	29B High Street, Rotherham.
1905 Jan. 28	JENNINGS, W.	Borough Engineer's Office, Leyton.
1907 May 25	JOHNSON, W. H.	Town Hall, Great Yarmouth.
1907 Sept. 7	JONES, F. E.	Lisbourne Farm, Lisbourne Lane, Stockport.
1903 July 25	JONES, T., A.M.Inst.C.E.	53 Princes Street, Southport.
1906 Dec. 15	JONES, T.	Townfield Road, West Kirby.
1906 May 26	KING, J. S.	Council Offices, Friern Barnet, New Southgate, N.
1903 June 25	KNIGHT, R. R.	Council Offices, Bromley, Kent.
1903 June 25	KNOWLES, G. P., A.M. Inst. C.E.	39 Victoria Street, S.W.
1907 Sept. 7	LAIRD, N. P.	Thurnby, near Leicester.
1905 Dec. 9	LAKE, W. S., A.M.Inst.C.E.	Borough Engineer's Office, Plymouth.
1906 Dec. 15	LEES, R. B.	99 Antrobus Street, Congleton, Cheshire.
1904 June 25	LEWIS, H. M.	Town Hall, Staines.
1904 Dec. 3	LINE, H. W.	L.C.C., 19 Charing Cross Road, S.W.
1907 May 25	LOACH, A. E.	Council House, Aston Manor, Birmingham.
1906 June 28	LUDFORD, E. W.	Belle Vue House, Ravenscourt Square, Hammersmith.
1905 Sep. 23	LYDDON, A. J.	Engineer's Office, 23 Valentine Road, King's Heath, near Birmingham.

Date of Election.		
1905 May 27	McArd, A. J.	Edge Hill, Whitehaven.
1900 Dec. 15	MacDonald, K. G.	13 Charles Street, St. James's, S.W.
1905 May 27	Maitland, W. H...	Town Hall, Hoylake, Cheshire.
1903 June 25	Mann, E. E., B.Sc., A.M. Inst.C.E.	Borough Engineer's Office, Southampton.
1904 May 28	Mansfield, F.	Town Hall, Hereford.
1903 Jan. 17	Marrian, H. G., Assoc. M. Inst. C.E.	Bank Chambers, Twickenham.
1906 April 28	Marsh, F. E.	Municipal Engineer's Office, Singapore, S.S.
1903 Jan. 17	Masters, W. H.	Glencairn, Arthur Road, Southampton.
1906 Dec. 15	Matthews, R. H...	178 High Road, South Tottenham, N.
1905 May 27	Matthew, S...	South Villa, Crow Nest Park, Dewsbury.
1900 June 16	Mattinson, H., A.M.Inst.C.E.	55 Piccadilly, Manchester.
1904 May 28	Millar, P.	Borough Engineer's Office, Southampton.
1901 Oct. 19	Milnes, B.	Town Hall, Birkenhead.
1905 May 27	Minors, E.	City Engineer's Office, Worcester.
1905 June 22	Morgan, G. L.	11 The Parade, Pontypridd.
1899 June 10	Moss, P. A.	Town Hall, Upper Street, Islington.
1902 Jan. 25	Moss, W.	14 Hesketh Avenue, Didsbury, Manchester.
1904 Dec. 3	Needham, J. E...	Municipal Engineer's Office, Shanghai.
1906 Jan. 20	Newsome, S. H.	City Surveyor's Office, Sheffield.
1904 May 28	Nicholls, R...	Borough Engineer's Office, Southampton.
1896 June 25	Nightingale, C. F.	"Endellion," Buchanan Road, Walsall.
1905 Sep. 23	Nighy, J.	"Highcliffe," Fulwich Road, Dartford.
1907 June 20	Ollevant, H. E.	"Norwood," Nelson Street, Rotherham.
p1905 Jan. 28	Owen, J., A.M.Inst.C.E. ..	Engineer's Department, L.C.C., Spring Gardens, S.W.
1901 Aug. 24	Oxberry, F. W.	Borough Engineer, Kendal.
1899 Oct. 21	Palmer, G. F.	"Oaklands," North Ormesby, Middlesbrough.
1901 Feb. 6	Palmer, W. L. F., Assoc. M. Inst. C.E.	City Engineer's Office, Bristol.
1906 Dec. 15	Parker, E.	Stretford District Council Offices, Old Trafford, Manchester.
1904 May 28	Parker, J.	9 Winchester Rd., Ilford, Essex.
1906 June 28	Parsons, A. S.	Borough Surveyor's Office, Aston Manor, Birmingham.
1906 Dec. 15	Peacock, J. L.	Sewage Works Contract, Mayfield, Sussex
1906 June 28	Pearce, W. H.	Borough Engineer's Office, Southend-on-Sea.

Date of Election.		
1904 June 25	Pearson, T. G.	Town Hall, Barrow-in-Furness.
1896 Feb. 22	Perkins, T. L., A.M. Inst.C.E.	P. W. D., Hong Kong.
1903 Feb. 21	Perrott, E. S.	6 Elliston Road, Redland, Bristol.
1903 Dec. 12	Persey, W. C.	Town Hall, Barrow-in-Furness.
1902 July 10	Phillips, R.	41 Okehampton Road, Willesden, N.W.
1901 Aug. 24	Pickin, W. H.	L.C.C. Works Department, Belvedere Road, Lambeth, S.E.
1904 May 28	Piercy, M. A.	The Grove, Eagle Road, Wembley, Middlesex.
1907 May 25	Pimm, G. B. R.	2 Lamorna Place, Devonport.
1906 Dec. 15	Pool, H...	10 Jasper Street, Hanley, Staffs.
1907 Mar. 2	Poulden, G. E. L., A.M. Inst. C.E.	c/o A. Scott, Esq., Santiago, Chili, S. America.
1888 Sept. 15	Pritchard, T., M. Inst. C.E.	264 Gresham House, Old Broad Street, E.C.
1898 June 30	Quick, A. H., Assoc. M. Inst. C.E.	"Inverness," Malvern Road, Thornton Heath.
1904 Dec. 3	Quirk, J. J.	Borough Surveyor's Office, Swindon, Wilts.
1900 Dec. 15	Rawstron, C. O.	Surveyor's Office, Rural District Council, Lichfield, Staffs.
1901 June 8	Read, F., Assoc. M. Inst. C.E.	Public Offices, Pentre, Rhondda, Glam.
1902 Nov. 8	Redford, W. T.	Town Hall, Eccles, Lancs.
1904 May 28	Richmond, W. S.	Municipal Offices, Highgate, N.
1908 July 18	Roberts, L. G.	189 High Road, Balham, S.W.
1907 Dec. 14	Roddan, T. K.	Office of Public Works, City Chambers, Glasgow.
1900 June 16	Rousell, A. J., A.M.Inst.C.E.	Borough Engineer's Office, Worthing, Sussex.
1905 June 22	Sagar, J. H.	Council Offices, High Street' Poplar.
1906 May 26	Sawdon, J. S...	Municipal Buildings, Cheltenham.
1904 May 28	Schlund, W. T. S.	"Dulce Domum," Cleanthus Road, Shooter's Hill, S.E.
1902 July 10	Shepherd, G. G.	Town Hall, Ilford.
1906 June 28	Sherwood, A. F.	Borough Surveyor's Office, Town Hall, Hammersmith.
1899 June 29	Simms, F.	Town Hall, Sheffield.
1905 May 27	Sissons, F. P.	Assistant Borough Engineer, Hanley.
1905 Oct. 28	Slater, E. A., A.M. Inst. C.E.	201 Malden Road, Colchester.
1906 June 28	Small, L. J.	Surveyor's Department, Hendon R.D.C., Great Stanmore, Middlesex.
1906 Jan. 20	Smith, A.	North Road House, Fareham, Hants.
1898 Jan. 15	Smith, G. H.	1 Worcester Road, Wimbledon, S.W.
1906 May 26	Smith, W. B.	Public Offices, Hampton, Middlesex.
1905 Mar. 4	Snape, A. E., M.Sc., A.M.Inst. C.E.	102 Queen's Road, Norwich.
1898 June 30	Spink, J.	City Surveyor's Office, Manchester.

Date of Election.		
1899 June 29	STANTON, F. W. S., A.M. Inst. C.E.	28 Baldwin Street, Bristol.
1907 June 20	STANYER, F.	Fullford House, Lichfield.
1904 June 25	STEPHENSON, W. E., A.M.Inst. C.E.	City Engineer's Office, Leeds.
1906 Mar. 8	SUTCLIFFE, H.	158 Todmorden Road, Burnley.
1906 June 28	TASMAN, H. E.	Town Hall, Islington, N.
1900 Dec. 15	TAYLOR, H. T.	3 North Terrace, Gt. Meols, Hoylake, Cheshire.
1902 July 10	TAYLOR, S.	Town Hall, Manchester.
1907 Sept. 7	THOMAS, E.	City Surveyor's Office, Manchester.
1907 Sept. 7	TOMEY, N. G.	86 Trinity Road, Handsworth, Birmingham.
1905 Sep. 23	TONGE, J. A.	125 Nottingham Road, Mansfield.
1900 June 16	TREMELLING, H., Assoc. M. Inst. C.E.	Borough Engineer's Office, Newport, Mon.
1903 Jan. 17	TRESEDER, F. H.	The Nurseries, Cardiff.
1904 May 28	TULLEY, G. W.	64 Ashley Terrace, Edinburgh.
1906 Sept. 22	TURTON, C.	Penkridge, near Stafford.
1905 Dec. 9	UNDERHILL, G. B.	St. Stephen's, Canterbury, Kent.
1904 May 28	VAREY, J. A.	Westhill House, Chapel Allerton, Leeds.
1905 May 27	VERNON, A.	Town Hall, Upper Street, Islington.
1906 June 28	WAINWRIGHT, H. C.	22 Haden Hill, Wolverhampton.
1888 Jan. 14	WARD, F. D., A. M. Inst. C.E.	16 Hackins Hey, Liverpool.
1897 June 19	WEBB, F.	Town Hall, Chelsea.
1898 Jan. 15	WELLS, F. B., Assoc. M. Inst. C.E.	c/o The Great Southern Railway Co., Buenos Aires.
1902 Sept. 6	WEST, A. S., A.M.Inst.C.E...	Borough Engineer's Office, Harrogate.
1902 Jan. 25	WHITE, C. D...	Surveyor to the Urban District Council, Newton Abbot.
1901 June 8	WHITEFORD, E. H., A.M. Inst. C.E.	Engineer's Office, Derwent Valley Water Board, Bamford, near Sheffield.
1901 June 27	WILLETT, A. J.	18 Castledine Road, Anerley, S.E.
1895 June 27	WILLIAMS, D. S.	Resident Engineer, Portsmouth New Waterworks, Farlington, Hants.
1900 Dec. 15	WILLS, A. J.	3959 Penngrove Street, Philadelphia, U.S.A.
1900 July 19	WRACK, W. P.	117 High Street, Poplar, E.
1904 June 25	WRIGHT, F. W.	Resident Engineer's Office, Sewerage Works, Camberley, Surrey.
1906 May 26	WRIGHT, W., A.M.Inst.C.E...	Borough Engineer's Office, Southend-on-Sea.
1906 June 28	WRIGLEY, G. E.	Surveyor to the Urban District Council, Sowerby Bridge.

STANDING COMMITTEES.

GENERAL PURPOSES COMMITTEE.

THE PRESIDENT (*ex-officio*).
J. PATTEN BARBER (ISLINGTON), *Chairman*.

W. N. BLAIR (St. Pancras).
J. A. BRODIE (Liverpool).
J. W. COCKRILL (Great Yarmouth).
A. E. COLLINS (Norwich).
C. H. COOPER (Wimbledon).
A. FIDLER (Northampton).
A. D. GREATOREX (West Bromwich).
W. HARPUR (Cardiff).
T. W. A. HAYWARD (Battersea).
CHAS. JONES (Ealing).
R. J. THOMAS (Bucks Co.).
H. T. WAKELAM (Middlesex Co.).
C. F. WIKE (Sheffield).
T. H. YABBICOM (Bristol).

FINANCE COMMITTEE.

THE PRESIDENT (*ex-officio*).
T. H. YABBICOM (BRISTOL), *Chairman*.

J. P. BARBER (Islington).
J. A. BRODIE (Liverpool).
A. E. COLLINS (Norwich).
W. HARPUR (Cardiff).
T. W. A. HAYWARD (Battersea).
CHAS. JONES (Ealing).
W. F. LOVEDAY (Stoke Newington).
P. H. PALMER (Hastings).
R. READ (Gloucester).
R. J. THOMAS (Bucks Co.).

PAPER COMMITTEE.

THE PRESIDENT (*ex-officio*).
H. T. WAKELAM (MIDDLESEX Co.), *Chairman*.

J. PATTEN BARBER (Islington).
J. A. BRODIE (Liverpool).
J. W. COCKRILL (Great Yarmouth).
C. H. COOPER (Wimbledon).
A. D. GREATOREX (West Bromwich).
T. W. A. HAYWARD (Battersea).
W. F. LOVEDAY (Stoke Newington).
J. S. PICKERING (Cheltenham).
R. READ (Gloucester).
R. J. THOMAS (Bucks Co.).

PARLIAMENTARY COMMITTEE.

THE PRESIDENT (*ex-officio*).
J. S. PICKERING (CHELTENHAM), *Chairman*.

J. P. BARBER (Islington).
J. A. BRODIE (Liverpool).
J. W. COCKRILL (Great Yarmouth).
A. E. COLLINS (Norwich).
A. T. DAVIS (Shropshire County).
A. FIDLER (Northampton).
A. D. GREATOREX (West Bromwich).
P. H. PALMER (Hastings).
H. E. STILGOE (Birmingham).
C. F. WIKE (Sheffield).

EDITORIAL NOTE.

The Council having decided that Volumes of "Proceedings" shall in future contain a complete record of the work of the Presidential year covered, the present (34th) volume terminates with the last District Meeting held under the Presidency of Mr. John A. Brodie, and the Annual Report of the Council for the year 1907–08.

Mr. Brodie's Presidential Address, together with the Proceedings at the last Annual Meeting will be found fully reported in Volume 33.

The Presidential Address of Mr. E. Purnell Hooley, with the Proceedings of the year 1908–09, will be reported in Volume 35.—Ed.

THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

METROPOLITAN DISTRICT MEETING.

July 6, 1907.

Held at Westminster.

J. PATTEN BARBER, M.INST.C.E., PAST-PRESIDENT,
in the Chair.

MR. BARBER apologised for the unavoidable absence of the President (Mr. John A. Brodie).

Mr. W. F. Loveday was unanimously re-elected Honorary Secretary for the Metropolitan District.

A general discussion then followed as to the advisability of holding quarterly meetings in the Metropolitan District, and it was finally resolved to recommend the Council to consider the question.

conveying the effluent to the carriers, and thence to the 12½ acres of land before discharging to the Brook.

Half-round pipes are laid on the top of the sandy surface-soil for distributing purposes, each pipe being controlled by a disc-valve in the walls of the distributing channels, and by stops in the pipes.

Great care has been necessary in the selection of the sandy surface-soil, since, if taken from any considerable depth, it does not contain the organisms necessary for purification purposes.

The machinery comprises two oil-engines, each capable of developing 6½ brake horse-power at 250 revolutions per minute; two horizontal, double-acting, single-cylinder guide-pumps for filtered water, 5-inch bore, 12-inch stroke, delivery 58 gallons at 40 revolutions per minute; two sets of horizontal three-cylinder ram pumps for sludge-lifting, 8-inch bore, and 18-inch stroke, each set delivering 350 gallons at 30 revolutions per minute. Two lime-grinding mills and lime-solution mixing-cylinders have also been provided.

Very great difficulties were encountered in the laying of the intercepting sewers in the main thoroughfares, owing to the presence of old colliery workings, and at one stage of the work it was necessary to temporarily shore the Lichfield Street elevation of the Town Hall, and afterwards to carry out special works to ensure the safety of the building.

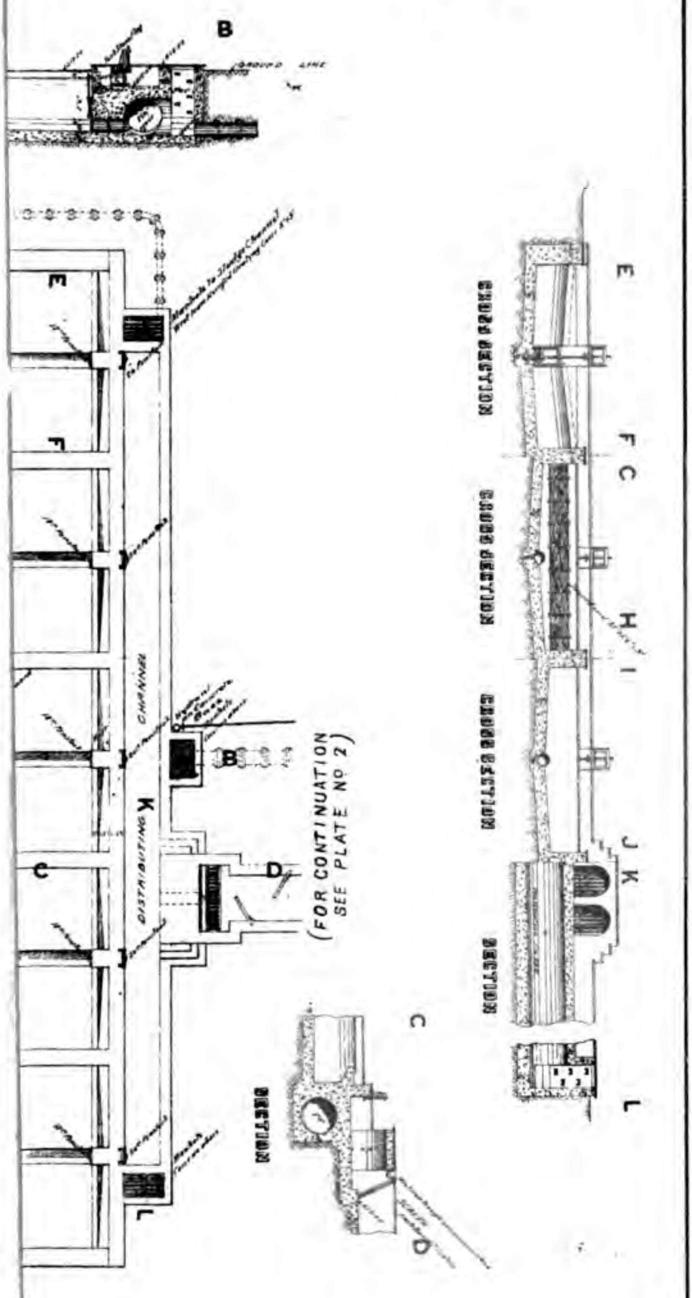
Arrangements have been made with the Wolverhampton Corporation for draining certain properties within their district which are at present unsewered, into the Bilston system.

The total cost of the scheme when completed will amount to about 52,000*l.*

South Staffordshire Joint Small-Pox Hospital.

This Hospital, which was opened on December 4, 1905, has been erected at Bradley in the Urban District of Bilston, and serves the County Borough of Wolverhampton, the Borough of Smethwick, the Urban Districts of Amblecote, Bilston, Coseley, Darlaston, Heath Town, Oldbury, Rowley Regis, Sedgley, Short Heath, Tettenhall, Tipton and Wednesfield, and the Rural District of Kingswinford, which districts were, by a provisional order made by the Local Government Board under section 279,

PLATE No. 1.



To face page 4

of the Public Health Act, 1875, formed into a united district, called "The South Staffordshire Joint Small-Pox Hospital District." The population of the area at the last census was 362,578, the rateable value 1,374,105*l.*, and the area 37,731 acres. A penny rate in the pound produces 5725*l.*

The site of the hospital is bounded on two sides by the Birmingham Canal, and is almost entirely isolated from dwelling houses. It is known as "Moorcroft Colliery," and contains a little over 56 acres.

The buildings afford accommodation for forty patients, and for a sufficient staff of nurses, etc., to look after a larger number of patients should an epidemic arise.

The building site is surrounded by an unclimbable galvanized iron fence 7 feet high, and consists of about 5 acres. The remainder of the site is fenced in with barbed wire fence.

Immediately at the entrance to the building site there is a lodge with discharge block combined.

The administrative block provides accommodation for a resident doctor, matron, and fourteen nurses and servants. A large cooking kitchen, surgery, and store-rooms, and the necessary bath rooms and sanitary accommodation are also included in this block.

The hospital itself consists of three pavilions. Nos. 1 and 3 Pavilions will accommodate sixteen patients each, and No. 2 Pavilion, which is an observation block for doubtful cases, will accommodate eight persons.

Each of these pavilions is divided into two wards (male and female) with a nurses' kitchen separating them. Bathrooms and sanitary conveniences are also provided for each ward.

The three pavilions are connected to each other, and also to the administrative block, by covered ways so constructed as not to prevent the free passage of air on all sides of the buildings.

A laundry, harness-room, stables, ambulance shed, accommodation for infected and disinfected clothing vans, mortuary, destructor, and disinfector have been provided.

Two concrete bases upon which additional pavilions or temporary accommodation may be erected upon emergency have also been constructed.

The mortuary is provided with an air-tight inspection window, through which identification may be made without risk of infection.

The buildings are erected in red brick, and are of the simplest character possible, without any attempt at ornament or decoration. They are erected on concrete bases interlaced with steel joists bolted together. The floors are of teak, and the walls, being faced with "Albino" cement, are perfectly smooth, and no mouldings or acute angles have been introduced. All the corners are rounded off so as to allow no possible resting-place for dirt or disease germs.

The buildings are lighted throughout by electricity, and the large pavilions are also wired for electric radiators.

The ventilation and heating are carried out by natural means. The windows open in the "hopper" form at the top, and the sashes at the bottom can be continually open so as to allow a current of fresh air without causing draughts. The Moorwood Hospital stoves draw in fresh cold air, which, after passing through the stoves, enters the wards in a warmed condition.

A special feature has been made of the doors, which are composed of deal and compo-boarding so framed together as to give a perfectly even surface on both faces without any mouldings or panels.

Exits are provided at the end of each ward in addition to the central entrances in case of fire or panic.

No complicated or expensive machinery has been provided which would require a skilled mechanic to be retained on the premises.

The bathrooms are grouped round the kitchen in each block, thus avoiding extensive hot and cold water mains.

The water supply is from the Bilston Urban District Council's mains, and provision is made for fire hydrants in each block and in the grounds.

The furniture is simple and strong, but suitable, and has been specially designed or chosen for the several purposes for which it is required to be used.

All the china, enamel, glass and cutlery are stamped and engraved, and the linen, etc., marked so as to distinguish the articles used by the patients from those used by the staff, and all from being used elsewhere.

A telephone has been installed in the buildings.

The drainage is treated upon the site, there being no main sewers within a considerable distance from the site.

The grounds in the building area have been laid out in a simple manner with shrubs and trees, and about 30 acres of the remainder of the site have been planted with trees by the Midland Re-afforesting Association. By this means it is hoped that the value of the property will be increased, and its appearance rendered more attractive.

The cost of the work, including the purchase of land, was £18,000.

The buildings were designed by Mr. George Green, Assoc. M.Inst.C.E., Borough Engineer, Wolverhampton.

STONEFIELD COUNCIL SCHOOL.

This School was opened on August 2, 1906.

When the Bilston Education Committee was first formed in September, 1903, in pursuance of the Education Act, 1902, it was at once apparent that further School accommodation was urgently needed in Bilston. The existing Schools were overcrowded, and the Committee felt that they should be put on the 10 square feet basis of accommodation as early as possible. With this proposal the Board of Education agreed, and urged the Committee to build Schools to provide for the surplus children.

The School, which accommodates 1200 children, is built on the class-room principle, and special centres are provided for instruction in Manual Training and Cookery.

Large Central Halls, 60 feet long by 26 feet 6 inches wide in the Boys' and Girls' Departments, and 62 feet by 24 feet in the Infant Department, are provided and so arranged in each case that the Head Teacher can exercise supervision over the Classes in the Class-rooms from the desk in the Central Hall.

In each of the Boys' and Girls' Departments there are six Class-rooms, measuring 25 feet by 24 feet, and one measuring 20 feet 6 inches by 20 feet. Arrangements are made in each of these departments for two of the larger Class-rooms to open, by means of folding partitions, to add to the space of the Central Hall.

In the Infant Department there are six Class-rooms, each 23 feet 6 inches by 23 feet 6 inches, and one 20 feet 6 inches by 20 feet.

There is also provided a Science Lecture Theatre, measuring 28 feet 6 inches by 22 feet at the angle of the Boys' and Girls' Departments, which will be used by these two departments only.

In each department there is a private room for the Head Teacher, and suitable cloak-room, lavatory, store, and play-shed accommodation is provided in accordance with the requirements of the Board of Education.

There is a Manual Training Centre, 62 feet by 22 feet, fitted up with work benches for woodwork. This centre is utilised by the children attending the upper standards of all the public elementary schools of Bilston.

The Cookery Centre adjoins the Girls' School, and is 32 feet 6 inches by 25 feet.

The School is fitted throughout with electric light and electric bells, and heated on the low pressure system. The furniture is on the dual desk system.

The total cost of this school, including the site of 3 acres, was 17,457*l.* 18*s.*, or about 14*l.* 10*s.* per head. Exclusive of Manual Training and Cookery Centres, the cost works out at about 13*l.* per head.

WATERWORKS.

The water supply to the township is derived from a well in the red sandstone situate at the Bratch, in the parish of Wombourne, about 7 miles from Bilston. The level of the floor of the engine house is 267 feet above O.D., and from here the water is lifted a height of about 440 feet from the level of the water in the well to the service reservoir, through some 4 miles of 14 inch main.

A very complete description of these works was given in a paper read by the late Mr. C. L. N. Wilson, at the District Meeting of this Association, held at Bilston, on September 17, 1898.

The following particulars may, however, be of interest:—

(A) Statement, showing the total income, expenditure, etc.

(B) The position of the loans at March 31, 1907.

A.

Year. March 31 to March 31.	Total income.			Total expenditure, including interest on and repayment of loans.			Interest on and repayment of loans.			Payments in excess of receipts.			Receipts in excess of payments.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1897–98	4709	5	5½	6456	15	4	3145	7	0	1747	9	10½	—		
1898–99	4865	8	3	6266	8	11	3135	8	4	1400	15	8	—		
1899–00	5017	19	5	6993	3	6	3771	14	6	1975	4	1	—		
1900–01	5243	8	5	7131	18	6	3687	9	10	1888	10	1	—		
1901–02	5389	11	4	7261	8	6	3785	17	2	1871	17	2	—		
1902–03	5534	9	4	6462	13	10	3220	4	3	928	4	6	—		
1903–04	5638	16	2	5989	16	0	3210	4	10	350	19	10	—		
1904–05	5875	10	10	6106	6	1	3193	2	8	230	15	3	—		
1905–06	6378	9	3	5977	3	1	3068	2	7	—			401	6	2
1906–07	6847	15	4	6643	17	8	3043	0	0	—			387	14	10

B.

Date.	Amount.	Rate of Interest.	Term of years.	Annual charge.	Amount outstanding at March 31, 1907.	Date when loan will be fully repaid.
	£	per cent.		£ s. d.	£ s. d.	
Feb. 23, 1894	10,000	3⅝	50	486 0 0	8,306 9 6	Feb. 23, 1944
June 27, 1894	25,000	3⅝	50	1089 19 9	22,297 17 4	June 29, 1944
Oct. 23, 1896	7,750	3	50	301 4 2	6,962 6 9	Oct. 23, 1946
Oct. 18, 1898	6,937	2¾	30	With interest 232 0 0	5,081 0 0	Oct. 18, 1928
Oct. 18, 1898	850	2¾	10	With interest 85 0 0	170 0 0	Oct. 18, 1908
Dec. 8, 1899	11,000	3½	50	With interest 220 0 0	8,800 0 0	Dec. 8, 1946
May 23, 1900	2,242	3¼	30	118 2 3	1,947 9 7	May 23, 1930
Sept. 23, 1903	1,500	3¼	30	With interest 50 0 0	1,318 0 0	Sept. 23, 1933

The following statement gives the consumption of water for trade and domestic purposes for the ten years ending March 31, 1907, from which it will be observed that with the exception of the years 1902–03 and 1903–04, the supply for trade purposes has steadily increased, the lowest consumption being 38,962,110 gallons in the year 1898–99, and the highest 69,968,842 in the year 1906–07.

The average daily consumption during the four consecutive years ending March 31, 1902, was at the rate of 19·48 gallons per head of the population. The average for the four consecutive years ending March 31, 1907, was 16·75 gallons per head per day of the population.

In these calculations the year 1897–98 has been ignored, as excessive amounts were pumped in the early months of that year, due to the fact that the pumps were used to enable the well-sinkers to complete the well.

	Business by meter.	Domestic, including miscellaneous business, watering streets, etc.	Total.
1897–98.			
Annual consumption	44,098,975	255,278,415	299,367,390
Average daily consumption ...	120,805	699,379	820,183
Daily consumption per head ...	3·89	22·56	26·45
1898–99.			
Annual consumption	38,962,110	233,987,560	272,949,670
Average daily consumption ...	106,745	641,062	747,807
Daily consumption per head ...	3·44	20·68	24·12
1899–00.			
Annual consumption	40,943,720	212,676,920	253,620,640
Average daily consumption ...	112,175	582,676	694,851
Daily consumption per head ...	3·50	18·21	21·71
1900–01.			
Annual consumption	48,024,000	228,802,605	276,826,605
Average daily consumption ...	131,572	626,857	758,429
Daily consumption per head ...	4·06	19·34	23·40
1901–02.			
Annual consumption	48,552,010	233,604,530	282,156,540
Average daily consumption ...	133,019	640,012	773,031
Daily consumption per head ...	4·09	19·69	23·78
1902–03.			
Annual consumption	46,054,087	199,566,398	245,620,485
Average daily consumption ...	126,176	546,757	672,933
Daily consumption per head ...	3·87	16·74	20·61
1903–04.			
Annual consumption	46,747,960	183,733,340	230,481,300
Average daily consumption ...	127,726	502,004	629,730
Daily consumption per head ...	3·90	15·32	19·22

	Business by metre.	Domestic, including miscellaneous business, watering streets, etc.	Total.
1904–05.			
Annual consumption	50,118,000	198,153,450	248,271,450
Average daily consumption ...	137,309	542,886	680,195
Daily consumption per head ...	4·09	16·17	20·26
1905–06.			
Annual consumption	57,548,040	213,078,235	270,626,275
Average daily consumption ...	157,666	583,776	741,442
Daily consumption per head ...	4·59	17·02	21·61
1906–07.			
Annual consumption	69,968,842	231,743,008	301,711,850
Average daily consumption ...	191,695	634,912	826,607
Daily consumption per head ...	5·59	18·51	24·10

VISITS TO WORKS.

The Members then drove in brakes to the new outfall sewerage works, which they inspected under the guidance of Mr. Wakeford and Mr. George Latham. They subsequently drove on to the South Staffordshire Small-Pox Hospital, and were shown over the premises by Mr. Green.

Lunch was partaken of at Bilston at the invitation of the Chairman and Members of the Council, Mr. Skemp presiding.

After lunch the members watched a tar-spraying apparatus at work, and visited the new Council Schools at Stonefield. They subsequently drove to the waterworks pumping-station, where the powerful machinery was inspected, and tea was partaken of at the invitation of Councillor Sankey.

MR. A. D. GREATOREX: I should like to propose a hearty vote of thanks to Mr. Wakeford for the paper he has written for the occasion, and also for the privilege he has given us of seeing the works we inspected to-day.

Mr. J. T. EAYRS: I have pleasure in seconding the vote of thanks.

Mr. WAKEFORD: I am obliged for your vote of thanks for the paper, which I should prefer to call a few notes on the works we visited. As a matter of fact the notes on the Hospital were supplied by Mr. Green, the Borough Surveyor of Wolverhampton, who was the architect of the building.

COMMUNICATED REPLY TO DISCUSSION.

Mr. G. GREEN, in reply to Mr. H. Richardson: The following are the particulars asked for regarding the Small-Pox Hospital:—

Space per bed. . . .	2028 cubic feet
Floor area per bed . . .	156 square feet
Window area per bed . .	40 „
Cost per cubic foot of the building .	about 8*d.*

Mr. G. B. LATHAM, in reply to Mr. A. Burton:

Question.—"I notice the capacity of the tanks is equal to 20 to 30 hours' dry-weather flow of sewage of future population. Will you say why this particular proportion is chosen?"

Answer.—"The capacity of the settling tanks is calculated that four of them will hold six hours' flow of an average rainy day, the average rainy day being arrived at by dividing the amount of rainfall by the number of days on which it falls, and in this case it came to 0·165 inch per rainy day."

Question.—"It appears to me that the thickness of 3 feet 6 inches medium so close in nature as that shown to us, would be liable to clog very soon unless the tank effluent is very clear. I should like to know if a similar bed for a similar kind of sewage has been in operation anywhere, and what has been the experience gained therefrom."

Answer.—"Filters of this description were first put down at Friern Barnet, and commenced working in 1887; the sewage was treated with sulphate of alumina and lime before going on to the filter. The effluent from the filters discharges direct into a stream without any land treatment. An analysis of the effluent from these works on September 5, 1899, after twelve years' working, was as follows:—

	Crude sewage entering works Sept. 5, 1899.	Effluent taken from No. 1 bed Sept. 5, 1899.
Total solid matter	98·7	63·1
Chlorine	9·24	8·17
Chlorine sodium chloride	15·22	13·42
Nitrogen as free ammonia	7·840	0·5040
Nitrogen albd. ammonia	0·3584	0·0291
Nitrogen as nitrates	—	8·640
Nitrogen as nitrites	faint trace	—

	Crude sewage entering works Sept. 5, 1899.	Effluent taken from No. 1 bed Sept. 5, 1899.
Oxygen absorbed in 3 minutes at 80° Fahr. ..	2·415	0·084
Oxygen absorbed in 4 hours	5·096	0·357
Oxygen absorbed after 5 days' incubation 80° Fahr. in 3 minutes	5·705	0·070
Suspended matter—		
Organic	115·10	
Inorganic	29·96	

"(Signed) R. H. Harland, F.I.C., F.C.S.,
"37, Lombard Street, E.C.

"This was without any preparation for the sample being taken, the visit being a surprise one. Similar filters have also been constructed at Pontefract, where lime precipitation only is used, the sewage being acid, and where the Local Government Board sanctioned the direct discharge into a stream without land treatment. There are also several places where these filters have been used with an effluent from a septic tank without any chemical treatment with very good results with careful management. Before these works were carried out an experimental filter was made and the effluent from it analysed, with the following results:—

Grains per gallon.	Sewage.	Effluent.
Dissolved solids	115·5	126·0
Chlorine	35·3	37·0
Nitrogen as free ammonia	2·680	0·069
Nitrogen as albd. ammonia	0·672	0·033
Nitrogen as nitrites	—	—
Nitrogen as nitrates	—	2·619
Oxygen absorbed in 15 minutes at 80° Fahr. ..	1·694	0·056
Oxygen absorbed in 4 hours	2·130	0·126
Suspended matter—		
Organic	2·53	mere trace
Inorganic	3·31	
Total	5·84	
Incubation 5 days at 80° Fahr.	Effluent clear and bright, no smell	

"(Signed) R. H. Harland, F.I.C., F.C.S.,
"37, Lombard Street, E.C."

Question.—"Upon what basis is the 133 gallons per yard for the filter 5 feet thick taken?"

Answer.—"The basis on which the sewage filters are calculated is 150 gallons per mean yard area of the filters. The surface area, owing to the ramp of the banks, is somewhat larger than the mean area, hence the figure 133 gallons per yard."

Question.—"With relation to the treatment of the sewage with lime for precipitating purposes, I should like to know what would be the probable result upon bacteria filters and upon the effluent resulting from alkalinity of the tank effluent."

Answer.—"We have found that a slightly alkaline effluent is good for these filters, but should the effluent be at all acid it will throw the filter out of work for a short period. It has been found at Friern Barnet that only a very small quantity of sulphate of alumina is required to be used."

Mr. G. GREEN, in reply to Mr. A. Burton:

Question.—"In the mortuary of the Small-Pox Hospital, as far as I could see, the lantern was protected inside with wire netting of about $\frac{3}{8}$-inch mesh. It seems to me that very much finer gauze ought to be used in order to prevent any flies from coming in contact with any bodies which might be deposited there, as I understand that such contact is a most dangerous cause of the spreading of this fearful disease."

Answer.—"With regard to the wire netting placed over the louvres of the mortuary, I may say that this was placed there to keep the birds from getting inside and building there; it was not in any way intended to keep out flies. I do not think there would be any danger arising from the latter insects, as the mortuary would be kept particularly clean, and the bodies would not be exposed. They would at once be put in coffins, and closed down; besides which the place would be abundantly supplied with disinfectants, which would keep the flies out."

WESTERN DISTRICT MEETING.

October 19, 1907.

Held in the Town Hall, Teignmouth.

W. HARPUR, M.INST.C.E., PAST-PRESIDENT, *in the Chair.*

MR. F. SLOCOMBE, J.P., Chairman of the Teignmouth Urban District Council, offered the Association a hearty welcome.

Mr. W. Harpur, having apologised for the unavoidable absence of the President, thanked the Chairman for the kind welcome he had extended to the Members of the Association.

The resignation of Mr. J. S. Pickering from the Western District Hon. Secretaryship having been received with regret,

Mr. T. Moulding, City Engineer, Exeter, was unanimously elected in his stead.

MUNICIPAL WORKS AT TEIGNMOUTH.

BY CHARLES F. GETTINGS, SURVEYOR AND WATER ENGINEER TO THE URBAN DISTRICT COUNCIL.

THE area of the Urban District (exclusive of area covered by water) is 1635 acres, the residential population about 8700, and number of inhabited houses 1950. During the summer season the population is increased by 5000. The gross rateable value is 46,950*l.*

The following satisfactory abstract is included in the Medical Officer's (Dr. F. C. H. Piggott, B.A., and B.C. Cantab.) Annual Report for the year 1906.

Births.		Deaths.		Deaths all ages.		Deaths in public institutions.	Deaths of non-residents registered in public institutions in the district.	Deaths of residents registered in public institutions beyond the district.	Nett deaths at all ages.	
No.	Rate.	No.	Rate per 1000 births registered.	No.	Rate.				No.	Rate.
150	17·42	14	93·3	124	14·40	4	0	10	134	15·56

The zymotic mortality 0·11 (compared with 1·52 for England and Wales).

Geological.

The geological formation is of the New Red Sandstone.

The mean rainfall is 33·04 inches, the number of wet days 176, and the mean humidity 82.

Roads and Streets.

The whole of the roads in the District, except private roads, are repaired direct by the Council, the length of main roads being 3¾ miles, and other roads 24 miles. The cost of the upkeep of the main roads is 485*l.* per annum, towards which the County Council contribute 375*l.* The County Council grant additional sums for improvements. The main roads are subjected to the heaviest traffic in the district, as they form the three principal entrances to the town.

Considerable attention has been given to the roads during the past three years, especially with regard to reforming the contour, in some cases as much as 6 inches having been taken off the crown of the road. Limestone and flint were the principal materials used, but, owing to competition, the Author has been able to practically discard both these materials for granite. The stone is obtained from the Trusham quarries. This material has been subjected to some severe tests, and is one favourably reported on by Mr. Lovegrove with regard to the attrition test. It is broken to an even size, the gauges generally being 1¾ inches and 2 inches. The average cost for coating with granite, including scarifying and rolling complete, is 9*d.* per sup. yard. Since using granite the cost of street scavenging has decreased, and a much improved surface has been obtained.

STRICT C

CROSSIN

10 Bolts, each 1½" diameter

" metal

Limestone is now used for tar macadam purposes only, and flints only in repairs to the outlying roads where it is less expensive carting owing to the pits being in the immediate vicinity. During the past twelve months the side streets have received special attention, and where the gradients will permit they have been coated with tar macadam. Last autumn and the early part of this season the east end of the Promenade was coated with tar macadam and asphalte, and just recently the length of road from the Beach Hotel to Courtenay House has been coated. The latter section had a large amount of material, principally granite, on the road, but was most irregular and lumpy. The whole area was scarified, the stone turned over and regulated and dry rolled. It was then coated with a 1-inch layer of fine asphalte and thoroughly steam rolled and sprinkled with dry limestone dust. The cost finished complete was 9*d*. per sup. yard. The section between Courtenay House and Pier entrance has been coated with tar macadam 3 inches thick, and a fine coat of asphalte to fill in interstices. The cost of this work was 1*s*. 3½*d*. per sup. yard. Both these sections will be open for inspection.

In a number of the by-streets asphalte paving 3 inches in thickness has been adopted for the footpaths, the lower two inches being of 1-inch gauge, and the upper layer of $\frac{3}{8}$ inch to dust.

Fortunately the Author is in a position to manufacture tar macadam and asphalte at a very moderate cost compared with many towns, the stone and tar being obtainable at a reasonable price. The latter is obtained from the Council's gasworks, and is very good in quality. The method adopted in making tar macadam and asphalte is as follows: The stone and chippings are delivered dry and put under cover in the depot. This material is then filled into drying machines, where it remains for a night. Iron mixing platforms are provided under the shed with the dryers immediately adjacent, and as the stone or chippings are drawn from the dryer they are thoroughly incorporated with a boiling mixture of tar, pitch, and creosote. The Author prefers to leave the material in the depot for a month before being used, as it has been found from experience that it is more satisfactory and wears longer.

Salt water is used for street watering with very satisfactory

results. The Author has experimented with several patent dust layers, and, in his opinion, some are not so good as sea-water.

The Author has carried out a number of road widenings and improvements, and the work has been principally done by direct labour, the total cost amounting to about 2500*l*.

Parks and Pleasure Grounds.

The total area of the pleasure grounds is about 12 acres, which embraces The Den, Bitton Park, and a number of small plots in various parts of the town. The whole of the grounds are maintained directly by the Council's staff, under the Author's supervision. All the bedding plants are propagated in the greenhouse adjacent to the lifeboat house, and the Author considers that the results achieved compare favourably with any other seaside resort of a similar size, and probably with many much more important.

A scheme for laying out the remainder of The Den has recently been submitted, which provides for the erection of a pavilion, and levelling the ground so that it can be adapted for bowls or other games.

Foreshore Protection.

The question of dealing with the Foreshore is continually being discussed, and the matter is a serious one financially for a small town and a difficult one from an engineering aspect. The sands are continually shifting according to local climatic conditions. The Author has prepared a scheme in which it is proposed to use the chain cable groyne as invented by Mr. Allanson Winn. The chief reason for this recommendation is owing to initial cost, and he understands that good results have been obtained on the west coast of Ireland. If any member can give information on this subject the Author will be pleased to receive it.

Sewerage.

The bulk of the sewage from Teignmouth is delivered into a storage tank in the harbour situate at Gales Hill, the capacity of this being equal to about 225,000 gallons. Until 12 months

ago this tank was not railed round, and had open grids for ventilators. A number of complaints were made with regard to the smell, and the Author advised fencing it in with iron railing, closing up the open grids, and providing one of Webb's patent sewer gas lamp extractors, together with three inlet shafts. The Council adopted these recommendations, and no objections have since been received. The lamp is doing its work very satisfactorily. The outlet from this tank is regulated by hand on the ebb tides.

There are three other sewer outlets on the Teignmouth side above Gales Hill which discharge directly into the river.

Shaldon and Ringmore were sewered at the same time as Teignmouth, and have a tank sewer which is worked in a similar manner to that at Gales Hill.

On the whole these arrangements give fairly satisfactory results, although occasional complaints are received through the sewage getting up the river, but it has not yet been sufficiently serious for the river authorities to take any action in the matter.

House Refuse and Street Scavenging.

Particular attention is given to the removal of house refuse. The central portion of the town is cleared daily, and with the exception of the outlying parts (which are cleared weekly) the refuse is removed from other portions of the district twice a week. There are no privies in the district, and the greater part of the collection is made from proper sanitary bins which are provided by the householders. Unfortunately the cost of removal is increased by the long distance to the tip, which is one mile from the centre of the town. The district being residential, a large portion of the refuse collected is of a light character, and the quantity removed during last year amounted to 5873 loads. The average cost per load is 2*s.* 10*d.*, including rent for tip.

A refuse destructor scheme was submitted some few years ago, and was deferred on account of the cost, but the Author considers this is the only practical and sanitary method of dealing with the difficulty, and one that will have to be faced.

The whole of the streets in the centre of the town are scavenged daily, and alternate days on the outside. Covered orderly wagons are kept going continually in the town.

New Streets and Buildings.

The model bye-laws and the Private Street Works Act, 1892, have been adopted, and are strictly enforced. About two years ago the Author submitted plans for standard sections for all new roads which the Council approved, and these are now strictly adhered to.

Three large estates are now in course of development, and a record number of plans for new houses have been approved during the current year.

Fire Brigade.

The Council have an efficient Fire Brigade, which is well equipped with modern appliances, including a Merryweather steamer and escape. All the members of the Brigade are connected by telephone, and there are three call stations in the town, in addition to the central station.

Public Conveniences.

The town has been rather deficient in the matter of public conveniences, as there are only three provided. The Author has prepared plans for a new underground convenience on the Promenade, which is now in course of construction.

The accommodation provided in this convenience is 11 urinals, 4 W.C.'s, and lavatory with 3 basins, together with separate attendant's store on the Men's side; and 6 W.C.'s, with lavatory of 2 basins on the Female side. The brickwork will be built in cement with vitreous brick, and the whole of the interior will be lined with 6 in. by 3 in. white glazed tiles. The fittings are to be in best heavy white glazed fireclay, and the woodwork in polished teak. The cost of the whole work complete, including drainage, will be 1020*l.*

Mortuary.

A public mortuary is provided at Gales Hill, and is fitted up with the usual equipment.

Burial Board.

The Urban Authority are constituted as a Burial Board, and the Author is Surveyor to the Board. About two years ago the Author was instructed to prepare plans, etc., for an extension of the existing Cemetery, and the Board purchased about 4½ acres of land immediately adjacent. The ground purchased has been enclosed with a dwarf stone wall and iron fence. About 2½ acres have been laid out, the remainder being left for further extension. The subsoil being wet, the whole of the land has been under-drained 12 feet deep. With the exception of the boundary wall and fence, the whole of the work was carried out by direct labour under the Author's supervision, and it has recently been completed. The total cost has been 4500*l*., including 2200*l*. for land.

Isolation Hospital.

This was erected in 1905–1906, the site of 1½ acres forming part of an estate of 6½ acres purchased by the Council for purposes of a Public Park, at a total cost of 3300*l*. The position was approved by the Local Government Board, with the stipulation that the area proposed to be reserved for Hospital purposes should be increased (by ½ acre) to its present size.

The site is an ideal one and overlooks the harbour; it is enclosed by a Karri close-pale fence 6 feet 6 inches high. The Council act as Port Sanitary Authority, and it is proposed to provide direct communication with the Harbour by means of a bridge across the intervening G.W.R. line, and private steps.

The hospital accommodation is for eight beds, the Board's recommendations as to wall, floor, and air space having been strictly adhered to. There is a Male and Female block, each having two wards with Nurses' Duty Room between, and bathroom, all communicating only with the external verandah. The two blocks are built end to end, but with the doors and

verandahs on opposite sides. The out offices, comprising slop-sink, W.C., and coal store, are built in the centre of each block, but separated from the main building by the verandah.

In a separate block is provided a Laundry, Reck Steam Disinfector with separate admission and delivery rooms, Mortuary, Ambulance Room, and Store.

The Administration House has accommodation for the Medical Officer, Matron, and three Nurses, and is connected by private telephone with each hospital block.

The buildings are faced with "Nori" bricks, with terra cotta heads, sills and strings, the walls are 16-inch hollow walls, and the roofs are covered with Portmadoc slates laid on close boarding and felt. The verandah and bath-room floors are laid in terrazo, all others are wood, the space underneath being covered with 6 inches of concrete. The wards are ventilated by means of floor ventilators behind each bed, with a counterpoise valve ventilator in the chimney, and a ridge extractor to each ward, and are heated by means of slow combustion open fire grates. All internal woodwork is flush with the walls, which are plastered, and all internal, external, and vertical angles are rounded. The verandahs are glazed with patent glazing. The sewage is treated by means of a covered settling tank and small percolating filter, being distributed by means of an automatic distributor, the effluent being discharged into the public sewer.

The cost, exclusive of purchase of land, was as follows:—Buildings, £2496; Fencing, £103; Disinfector, £103; Outfall Works, £42; making a total cost of £2744, or a cost per bed of £343.

WATER SUPPLY.

Source.—The water supply for Teignmouth is obtained from three sources, viz.: a deep well and borehole situate at Mylor, the Venn, and Haldon Streams.

For distribution purposes the district is divided into two zones; the High Level reservoir known as Hazeldown is situate on Haldon Hill, the top water-level being 424·5 feet above O.D. It is covered in, and divided into two compartments, the total capacity being about 1,600,000 gallons. This

reservoir is supplied from the Haldon Spring and Mylor Well. The Low Level reservoir is situate at Landscore, is covered in, has one compartment, and the capacity is about 300,000 gallons; the top water-level being 133·0 above O.D. It is supplied by the Venn Stream and Mylor Well and bore hole.

Mylor Well.—Mylor Well is 82 feet deep, 10 feet in diameter, and is connected with adits which are driven from another well situate about 45 yards West. The total length of the adits is about 102 yards, and the diameter 5 feet.

Mylor Pumping Plant.—The following is a brief description of the engines, gas plant, and pumping machinery:—Two Crossley gas engines of sixteen nominal horse-power, and 6-inch water vessels for each engine, with complete sets of water-circulating, air, and exhaust pipes, the latter being carried out to silencers outside the engine house. The gas plant consists of a patent Economic plant, with one generator, hydraulic box, superheating boiler and feed pump, one washer and one gas holder 6 feet diameter by 6 feet deep, with combined tank and scrubber. One set of 3-throw pumps, 9-inch diameter barrels, with 24-inch working stroke, which are capable of lifting 222 gallons per minute through 440 yards of 8-inch rising main to Landscore reservoir, which is a lift of 132 feet. There is also one set of 3-throw pumps, 5 inches diameter, with 12-inch stroke, which are capable of lifting 56 gallons per minute through 900 yards of 4-inch rising main to Hazeldown reservoir, a lift of 423 feet 6 inches. The pumps are fixed at the bottom of the dry well, which is inside the pumping station, and 55 feet below floor-level.

In addition to the above plant there is a 10-inch borehole sunk through the centre of the wet well, which is 332 feet below ground-level, and is lined with steel tubes for 282 feet in depth. A borehole pump was fixed, together with a temporary 10-horse-power vertical engine and boiler. Unfortunately this plant had not given satisfaction when the Author commenced duties, as considerable trouble was experienced with the buckets. About eighteen months ago the whole of the tubes were drawn, together with the barrel and bucket. The old barrel and bucket was replaced, and since that time has given complete satisfaction. This source is only used to augment

the Low Level supply when we have practically exhausted the water from the deep well.

The nature of the strata at the bottom of the borehole is of a soft red sandstone, consequently the water is very thick when delivered, and it was found absolutely necessary to provide filters. Two high-pressure filters were provided, and the water is pumped direct from the bore-hole through the filters and on to Landscore reservoir. The filters are capable of dealing efficiently with 6000 gallons per hour.

Shaldon.—Shaldon and Ringmore have an independent water supply, which is obtained from a shallow well 28 feet deep. There are two adits driven from the well, one being 25½ yards North, and the other 8½ yards South. The strata is principally red sandstone.

Shaldon Pumping Plant.—The pumping plant at this station was erected in 1885, and consists of one set of 3-throw 4-inch Tangye's pumps, and is driven by an 8-horse-power nominal Tangye's steam engine in duplicate. The necessary steam is supplied by a Cornish boiler 10 feet long by 3 feet 6 inches in diameter in duplicate. There is a 5-inch rising main connecting to a covered service reservoir, the capacity of the latter being about 100,000 gallons.

Holne Moore Scheme.—In consequence of the insufficiency of the supply from existing sources, and the liability of occasional contamination, the Council have considered the question of augmenting the supply for a number of years, and have had many schemes before them. On the author's appointment some three years ago an agreement had just been entered into with the Paignton Urban District Council, to take a supply in bulk from their Holne Moor reservoir, and one of his first instructions was to submit a scheme for a line of route connecting with the Paignton main. Innumerable difficulties had to be considered owing to the immediate vicinity being intersected by various clay mines, quarries, and rivers, and eventually four alternative schemes were submitted, when, on the Author's recommendation, the Council decided to adopt the one now in progress.

The general plan and key sections will give an idea of the line of route adopted, also of the configuration of the country. With the exception of the approaches to the river the whole

line of route is along the public highway, but notwithstanding this the cost of easements has been a serious item. The mains in each case gravitate direct to the existing service reservoirs, the length between Park Hill and Hazeldown reservoir (about 10½ miles) being 9 inches in diameter, with a duplicate across the river Teign. The supply for Shaldon branches off this main at Netherton, when there is about 3 miles of 4-inch main to Shaldon reservoir. Landscore supply branches off at Coombe Vale with about half a mile of 6-inch main connecting to the reservoir. The mains pass through five villages in the Newton Abbot Rural District Council area, and an agreement has been entered into with this authority to supply them if required.

At Park Hill intake a meter-house is provided, and 9-inch Venturi meters with recorders complete in duplicate will be fixed. Meters will also be fixed on each supply main.

Probably many members will be interested in the sections, as the gradients and pressures are unusually heavy, the heaviest being on the section across the river Teign. After calculating the various thicknesses required for cast-iron pipes, and finding them so heavy, and considering their liability to fracture, the Author decided to consider steel as an alternative. At that time only short lengths of steel pipes had been used for waterworks in this country, although a large number had been used for gas, especially at Bournemouth, hence there was a difficulty in obtaining reliable data.

A list was obtained from the British Mannesmann Tube Co. giving the whole of the waterworks they had supplied on the Continent, and the Author got in touch with each engineer. In this manner he obtained valuable information, especially with regard to the life of the pipe, and he cannot pass by without acknowledging the extreme courtesy and trouble taken by the various continental engineers, which he considers might be copied with advantage by his own countrymen. Further to these inquiries he made exhaustive tests at the Company's works, and after making careful calculations, he came to the conclusion that he could safely recommend his Council to adopt their use, and effect a considerable saving on the initial cost of the scheme. The complete scheme was submitted to the Local Government Board for cast-iron pipes at an estimated cost of £23,600, but

at the Inquiry an amended scheme for steel pipes was submitted, the estimated cost being £19,300, or a saving of £4300. The Author is pleased to inform the members that the Board sanctioned the amended loan without alteration, but stipulated that the main should not be tapped, which is not in any way a disadvantage in this case. It may be interesting to the members to know that this was the first complete scheme sanctioned by the Board where steel pipes were proposed to be used. Since that time a number of others have been submitted. The Author is also pleased to say that his estimate of saving has been fully confirmed by the amount of tender accepted for the work.

The type of pipe adopted for ordinary mains is of the spigot and faucet, the joint being made with lead wool, and the latter has been found advantageous for high pressures. A special flange pipe is being used for the river crossing, and is rather unique, as the Author is not aware that it has previously been used on waterworks. The spigot and faucet pipes are tested to 600 lbs., and the flange pipes to 1000 lbs. per square inch before leaving the works. The whole of the mains are being tested to a pressure of 520 lbs. per square inch before being covered in.

The river crossing is about a quarter of a mile wide, the channel being about 50 yards wide at low water, with a minimum depth of 2 feet of water, and the tide rises from 10 to 12 feet. The Harbour Commissioners stipulated that there should not be less than 3 feet cover to the top of any work across the channel portion, and as this portion is surrounded with 12 inches of concrete, the depth to the bottom of the trench is about 8 feet below low-water line. This portion of the work was carried out in a cofferdam, but considerable difficulty was experienced owing to the nature of the ground and the large amount of water met with in the bottom of the trench. Special stop-valves are being provided on either side of the river, with an arrangement devised by the Author for checking the flow of water on either side.

The Author regrets that pressure of work has prevented him from giving further details, especially with regard to the detail cost of works, and tabulating the many experimental -ts he has made with the steel pipes. Since having this

scheme in hand he has received many inquiries from various engineers, and has endeavoured to give the information asked for, but should there be any point on which he has not dwelt in this paper that members may require information upon, he will be pleased to supply it if possible on request.

The past three years has been an exceedingly busy time for the Author, but his additional labours have been made much easier through the courtesy extended to him by the members of his Council, and he would like to take this opportunity of expressing his appreciation for their assistance, also to his staff for the loyal services rendered.

The Author cannot conclude without saying that he fully appreciates the honour the Association are conferring on his town by paying this visit, and he sincerely hopes that the members will find something of interest, and will leave with good impressions.

DISCUSSION.

Mr. S. Hutton: I have pleasure in proposing a vote of thanks to the Author. I have found at Exmouth that great use can be made of the local stone which can be obtained across the bay at Babbacombe. The limestone is very well suited for back-roads and roads which have not much traffic. I find by laying it in March and tarring it over with hot tar about June we get a surface which is almost equal to tar macadam. I have some terraces done in this method which have been in use eighteen months. I find that the use of sea-water spread by one of the spreaders keeps the dust down very well. The only other matter to which I wish to refer is the use of steel tubes for the water mains. The question is whether it is economy in every case. I am commencing to lay $1\frac{3}{4}$ mile of 9-inch and 10-inch mains at Exmouth, and the price laid complete for cast-iron pipes is 1786*l.* The tender for steel tubes alone was 1691*l.*, so if I had used steel tubes at Exmouth the work would have cost 200*l.* more. Of course I have everything in my favour at Exmouth, as the farthest point is only a mile and half from the railway station. It seems to me that steel tubes may be the proper thing to use in an outlandish place where the carting is very costly. Where

the work is near to a railway station cast-iron pipes are still the cheaper.

MR. W. HARPUR: I should like to second the vote of thanks to Mr. Gettings for his paper.

MR. OWEN BAINES: I think Mr. Gettings has made a new departure in using these steel tubes, and he has had a good deal of pluck in making a beginning. I know he has a difficult undertaking in carrying the main across the river, and I wish him every success in the work.

The vote of thanks was unanimously passed.

MR. C. F. GETTINGS, in reply: I have been amply repaid by the reception which my paper has met with from the members. The Western district has not the best of reputations for push, and the meetings have not been well attended. I hope the Western members will endeavour to support Mr. Moulding in any future meetings he may arrange, as although a meeting may be held in a small town, and there may not be extensive works to inspect, yet from the mere fact of a number of members gathering together to discuss matters among themselves there must be something gained by it. I certainly think it would be to our advantage if a few more meetings could be arranged in the Western district. With regard to Mr. Hutton's remarks, the adoption of steel tubes for small-sized water mains is a new thing in this country, and in making comparisons local circumstances must be considered. If you have had an opportunity of looking through the sections you will notice that our pressures are exceedingly high, varying up to a maximum pressure at the river of 380 lbs. to the square inch, and you all know that it requires a very heavy section of cast-iron pipe to withstand that pressure. I do not know what pressures Mr. Hutton has to deal with at Exmouth, but the great point which induced me to decide upon the use of Mannesmann steel tubes was the extremely high pressure I had to deal with. When I tell you that if cast-iron pipes had been adopted a large proportion of the pipes would have been $\frac{7}{8}$ inch and 1 inch in thickness, you will see that the cost of cast-iron pipes would have been very heavy. That has a great deal to do with the favourable comparison of the cost of pipes, and if Mr. Hutton has only a light section to deal with, such as $\frac{1}{2}$ or $\frac{5}{8}$ inch in thickness, it will make a considerable

difference. The other advantages in favour of tubes are the small number of joints to be made with pipes of 30 feet average length, and the easy manner in which they can be manipulated, making a differenco both in the labour in excavation and laying as compared with 9-inch cast-iron pipes. With regard to the joints there is a point not mentioned in the paper. We are using lead wool for jointing, and I have tested the 9-inch pipe with a 3-inch faucet up to 1000 lbs. satisfactorily. The Local Government Board stipulated that we should not tap the main. Where connections have to be made special branches are provided for this purpose if required. With a view of meeting this objection in any future case, the Company have manufactured a pipe with a thickened shell about 2 inches in width, so that the thickness will correspond with a cast-iron pipe, and the tapping can be done in the usual way. It is anticipated this will get over the Local Government Board objection. A few sections of pipes are in the room for inspection, and you will have the opportunity of inspecting them on the works.

The Members then proceeded in brakes to inspect the Mylor Waterworks Pumping Station, with Candy high-pressure filters; the Bitton Isolation Hospital, and by motor-boat inspected the laying of the water-pipe line with British Mannesmann steel tubes across the tidal river Teign. This inspection had to be made at low tide.

On returning to Teignmouth the Members were entertained to luncheon by the Chairman and Members of the Council.

In the afternoon a visit was made to the clay mines and pipe and brick works of Messrs. Hexter, Humpherson and Co. A number of interesting tests were made on various sized pipes for both internal pressure and crushing strain. At the conclusion of the inspection the Members were entertained to tea.

HOME DISTRICT MEETING.

October, 26, 1907.

Held at Hampton-on-Thames.

JOHN A. BRODIE, M.ENG.WH.SC., M.INST.C.E., PRESIDENT, *in the Chair.*

THE Chairman of the Urban District Council, Mr. J. J. Draper, J.P., welcomed the members to Hampton.

The President, on behalf of the Association, thanked the Chairman for the kind welcome he had extended.

The resignation of Mr. R. J. Thomas from the Home District Hon. Secretaryship having been accepted with regret, Mr. S. H. Chambers was unanimously elected in his stead.

SOME INTERPRETATIONS OF SEWAGE PURIFICATION PHENOMENA.

BY SIDNEY H. CHAMBERS, SURVEYOR TO THE HAMPTON URBAN DISTRICT COUNCIL.

THE degree of purification which sewage undergoes within the narrow limits of a practicable treatment area has been assumed to be inherently and absolutely a bacterial operation. Indeed, it has been stated categorically that the difference between the foul turbid sewage entering such an area and the clear, or only faintly opalescent liquid, free from smell, leaving it, was and must be regarded as the expression of the work accomplished by these micro-organisms.

This theory had its origin in the inference that the destructive operation in nature upon dead and excrete organic matters was entirely effected by the agency of bacteria. Moreover, in order to substantiate the hypothesis, it was necessary to draw the somewhat specious deduction that what was happening under natural conditions in connection with a small amount of organic matters when placed upon a large extent of surface, would occur when the entire sewage of a district was disposed upon a comparatively insignificant prepared treatment area.

The fact that in nature the destructive operation is a complex one, in which bacteria play only a part, was to a great extent ignored. As was also the even more important fact that notwithstanding the large extent of surface to which organic matter is under natural conditions applied, yet accumulations of such matter, and its retention in the soil for years awaiting destruction, are of the very essence of the operation, and constitute, especially in this connection, factors of far greater moment than those associated with the change to which some portion thereof is annually subjected.

In ordinary farming operations estimations as to the value of manure applied are based upon the assumption of an accumulation within the soil, and of a slow recovery from it. From which tables have been drawn up showing that the compensation value of the unexhausted manurial residue in the land is calculated upon the basis of a gradual removal of organic matters from the soil extending over a period of eight years.

Further, the cultivation effect in assisting the withdrawal of organic accumulations should not be lost sight of, as an additional operation not occurring in artificial treatment areas.

In the destructive process in nature the scavaging action of animals constitutes no unimportant consideration in reducing the grosser organic solids. Whilst these scavengers are, in the main, excluded from sewage treatment areas, yet the amount of work effected therein by worms, flies, and other animals beyond the range of organisms generally understood to be concerned in the biological, and certainly excluded from the bacteriological operation, is not yet fully appreciated.

The due recognition of these facts should have occasioned considerable disquietude in the minds of the pioneers of the all-bacterial system of sewage purification, and ought to have

prepared them and others for the accumulations in tanks, beds, or other filtration area, which are everywhere the sign-manual of the bacterial system of sewage treatment.

In order to be able to thoroughly appreciate the deductions which were drawn from experimental determinations in the earlier stages of the movement, and the theories formulated thereupon, it is desirable to quote from the writings of some of those who took a foremost place in the elucidation of the subject. In so doing, as well as in the subsequent criticism, it should be distinctly understood that it is not, in any way, intended to detract from either the value or the magnitude of the work referred to. More especially is this the case since the views then held have, by their authors' more recent investigations, been considerably modified in the direction indicated in the present contribution. Indeed, were it not that these earlier statements still exert an influence upon the minds of many, and are not foreign to some who have been conversant with the subject from its initiation, but who have not been able to shake themselves free from the trammels of what cannot but be regarded as indeterminate experiments and inconclusive observations undertaken in the earlier period—were it not for these facts, one of the main grounds for this communication would be non-existent.

The first reference is to the publication "Experimental Investigations by the State Board of Health of Massachusetts upon the Purification of Sewage by Filtration and by Chemical Precipitation, and upon the Intermittent Filtration of Water, made at Lawrence, Mass., 1888–1890" (Boston, 1890), where on page 578, under the heading "A General View of Results," the following may be found:—

"The truths in regard to filtration of sewage that have been made manifest by the experiments of the State Board of Health in the past two years can be appreciated only by a careful study of the results which have been presented. No statement of general conclusions can convey all that these experiments have made known; but, to one who has carefully considered the results in detail, it may be useful to group the results and bring out some of the general truths with more clearness.

"The experiments with gravel stones give us the best illustrations of the essential character of intermittent filtration of

sewage. In these, without straining the sewage sufficiently to remove even the coarser suspended particles, the slow movement of the liquid in thin films over the surface of the stones, with air in contact, caused to be removed for some months 97 per cent. of the organic nitrogenous matter, a large part of which was in solution, as well as 99 per cent. of the bacteria, which were of course in suspension, and enabled these organic matters to be oxidised or burned, so that there remained in the effluent but 3 per cent. of the decomposable organic matter of the sewage, the remainder being converted into harmless mineral matter.

"The mechanical separation of any part of the sewage by straining through sand is but an incident which, under some conditions, favourably modifies the result; but the essential conditions are very slow motion of very thin films of liquid over the surface of particles having spaces between them sufficient to allow air to be continually in contact with the films of liquid.

"With these conditions it is essential that certain bacteria should be present to aid in the process of nitrification. These, we have found, come in the sewage at all times of the year; and the conditions just mentioned appear to be most favourable for their efficient action and, at the same time, most destructive to them and to all kinds of bacteria that are in the sewage."

The next quotation can be seen in Mr. Dibdin's book, "Purification of Sewage and Water, 1897," pp. 62 and 63, and is to the effect that—

"The following is a summarised statement of the work accomplished by the one-acre coke breeze filter at the Northern Outfall between September, 1893, and November, 1896, during which period it had filtered 500 million gallons of effluent. Since the effluent, which is passed on to the filter, contains, on an average, seven grains of suspended matter per gallon, a quantity equal to 2232 tons of sludge of 90 per cent. moisture has been removed, the filtrate containing practically no suspended matter. Of the matter thus removed, about 110 tons were organic, the whole of which has been oxidised; whilst the sand amounted to about 40 tons, which, calculated at 24 cwts. per cubic yard, would cover the filter to a depth of 0·267 inch if spread equally over its surface. Such sand has, however, been carried into the body of the coke, and at present there is

no appearance of any danger of choking arising from this cause. The organic matters in solution in the crude effluent absorb, on an average, 3·5 grains per gallon of oxygen from permanganate in four hours, while the filtrate absorbs only 0·7 grain. The amount of oxidation effected in this way would require 90 tons of oxygen, or, in other words, is equal to the effect which could be obtained by the use of about 2000 tons of good commercial manganate of soda. The organic matter in solution that has been completely removed, as determined by the difference between the loss on ignition of the solids in the crude effluent and the filtrate respectively, amounts to 250 tons; making with the 110 tons of suspended organic matter a total of 360 tons. The organic matter that remains in the filtrate is in such a condition that no signs of after putrefaction are exhibited, however long the filtrate may be kept, either undiluted or diluted, in open or closed bottles."

These statements, it will be seen, are definite, and do not admit of even the faintest shadow of doubt being cast upon the meaning of what was intended to be an accurate interpretation of sewage purification phenomena. The respective authors originate and lend the weight of their authority to the doctrine that in treating sewage by intermittent filters and in contact-beds all the organic solids present in the sewage, whether in a condition of suspension or of solution, and not appearing in the effluent, had been, and presumably would be, oxidised and burned in any suitably arranged treatment area, and would be converted into harmless mineral matter by bacterial agency. In other words, that, in such an area, the difference between the sewage and the effluent ought to be expressed in terms of matters actually destroyed, and should be regarded as the measure of bacterial activity. Further, the material of the filtration area is taught to be practically inoperative as either a strainer of the sewage, or as a collector of sewage matters; any mechanical separation effected, even by material as fine as sand, is held to be "but an incident, which, under some conditions, favourably modifies the result."

Since the material must be so regarded; and since the doctrine does not admit of any accumulation of organic matters, whether of recent origin or in process of disruption—for the statement on this point is quite clear, "the whole has been oxidised" —it follows that a logical interpretation of this doctrine must

include the conversion of the organic solids, suspended and soluble, into mineral matters during the time occupied by—*pari passu* with—the flow of liquid through the treatment area. This interpretation of sewage purification phenomena has the merit of consistency, in that suspended and soluble organic matter are both and with equal readiness destroyed. It is not, however, in accord with the observed phenomena, and it is not true.

Every person, at all acquainted with the subject, would now, from practical observation, be prepared to deny the truth of this statement as regards the rapid and complete conversion of the suspended organic matter, whilst, at the same time, they might hesitate to refute and might even, following the generally accepted opinion, affirm the rapid conversion of the soluble organic matter. In this connection the opinions of Col. T. W. Harding and W. H. Harrison, M.Sc., as recorded in the "City of Leeds Reports on Experiments in Sewage Disposal, 1905," based upon observations made during the years of 1898–1905, may be considered as peculiarly apposite, and are expressed in the following quotations:—

"It was impossible not to be struck by the rapidity in which the chemical changes were brought about. In order to test the speed at which the sewage came through the filter, repeated trials were made as follows:—

"About a litre of alkaline fluorescine solution, a very powerful colouring matter, was poured into the channel carrying the sewage to the sprinkler, and the time carefully taken before the colour began to appear in the filtrate as it ran out of the bottom. It usually took three minutes before the full coloration appeared, though there was clear evidence of it after 2½ minutes, the depth of the material in this bed being 12 feet and the grade very coarse indeed. The changes brought about by bacterial action are therefore remarkably rapid as regards dissolved impurities, but it is not, of course, suggested that the action on suspended solids is also so rapid. On the contrary, the dissolution or transformation of the matter in suspension in sewage is a slow one, and when finely divided solids come through a percolating filter, brown in colour and well oxidised, the process has probably required seven to fourteen days. At least, judging from the time which passes before suspended matters come through in a new filter, it takes

these fully that time to work gradually down, washed forward by the liquid which itself comes through in three minutes," p. 104.

"The action of the oxidising bacteria of a percolating filter on dissolved impurities is strikingly rapid," p. 119; and

"The experiments detailed in this report show how important is the question of the suspended matter in sewage. By bacterial processes the oxidation of dissolved impurities is rapid and easy, but that of the suspended matter is very slow, and there is always a large irreducible residuum," p. 146.

These opinions record an advance which had, in the mean time, declared itself in the knowledge of sewage purification phenomena, bringing these phenomena more into line with those previously referred to as occurring under natural conditions. For experimental observations as well as practical operations had by this time determined that the dissolution of organic "suspended matter is very slow, and there is always a large irreducible residuum."

Had the earlier statements referred to been confined, as they were purported to be, to the truths in regard to filtration —in connection with which the authors had obtained accurate scientific information—the advance in the knowledge of sewage purification methods would have been none the less considerable, and little grounds for criticism and subsequent disappointment would have arisen.

Truth, however, was blended with fiction, and assumption took the place of accurate scientific observation. Indeed, the statement as to the entire conversion of the organic solids into mineral matter is contradicted by the voluminous analytical data from which the conclusion was drawn, which show only a modicum of such conversion.

Reference has already been made to the fact that the continuation of the exhaustive Lawrence experiments and the later investigations by Mr. Dibdin have considerably modified their earlier views. It would, therefore, be obviously unfair to exclude these whilst adducing the later observations of others.

The more recent Annual Reports of the State Board of Health of Massachusetts have consistently referred to the presence of accumulations of organic matters in every one of the many filters operated upon during the last twenty years. These accumulations have occurred irrespective of the rate of flow of

the sewage, even when that flow has been as low as 20,000 gallons per acre per day; notwithstanding the comparatively weak character of the sewage operated upon; and independent of the material, which has been of variable sizes, down to the finest river silt averaging about 0·004 inches in diameter. The Reports have demonstrated the necessity for the removal of these accumulations from the filters in order to prolong their period of practical usefulness, and have recorded numerous experiments, including cropping, undertaken with the object of ascertaining if it were in any way possible to insure the conversion of some proportion of the retained organic matters. In addition they have "clearly shown the stable nature of a large percentage of this organic matter," which they have described as "stable as soil nitrogen which remains year after year at practically the same point unless exhausted by severe cropping." This statement practically identifies the already referred to accumulations in nature with those which, it was also held, must occur in sewage-treatment areas.

Mr. Dibdin has modified the views he previously held, in that he now provides means for the more expeditious removal of the accumulated sewage solids, the organic portion of which he formerly held to be totally destroyed.

In the light of this dual recantation; considering the exhaustive character of the experiments at Lawrence and the prolonged period over which they were conducted, together with the definiteness of the statement as regards the practical indestructibility of a large percentage of the accumulated organic matter; having regard to the results of the Leeds experiments already quoted, and to the fact that, but for fear of overburdening the communication, numerous other experiments, equally conclusive, might have been adduced; and finally, viewing the general effect of the practical operation, there is demonstrated, incontrovertibly, the ever-present existence of more or less extensive accumulations of organic solids on, in, or passing out of the treatment area.

Under these circumstances to again formulate a doctrine in which the accumulation of organic matter in the filtration area is both ambiguously denied and practically ignored, and to advise local authorities to this effect, is in the highest degree to be deprecated. Yet such is the attitude taken up by Dr. George Reid, in a paper on the "Nitrification of Sewage,"

which appeared in the *Contract Journal* on the 18th and 25th ultimo.

Dr. Reid, in discussing the effect of the Hanley operation upon suspended solids, states that the preliminary treatment resulted in an effluent which was "passed on to the filter containing 7·6 parts per 100,000, exactly one-half of which is mineral matter. This suspended matter, it will be seen, is practically all retained in the top layer of the filter, where the organic portion is liquefied in all probability by aerobic organisms. The mineral matter, however, must remain in the filter, and in time, no doubt, it will be found necessary to remove the filtering medium to a depth of a few inches for the purpose of washing it, but so far, after over three years' constant working, no such necessity has arisen. As a matter of fact, if the total mineral suspended solids passing on to the filter during the three years were deposited in a uniform layer over the whole surface, the depth of the coating would be less than 1¼ inches."

If a comparison be made between this statement and that of Mr. Dibdin's, previously quoted, as to the working of the Barking contact beds, striking similarities will be revealed. Indeed, with the exception of the calculation in Mr. Dibdin's statement as to the amount of suspended and soluble organic solids destroyed, the two are practically identical. Dr. Reid, however, makes up for the omission by specifically stating the liquefactive nature of the operation, and where it takes place—"the organic portion is liquefied in all probability by aerobic organisms," and "in the top layer of the filter."

In addition, in referring to Mr. Scott-Moncrieff's experimental work, Dr. Reid says—

"I feel pretty confident that, had a much finer filter medium been used by Scott-Moncrieff, the high oxidising changes would have been effected at a shallower depth, and practically the whole of the suspended solids would have been liquefied and nitrified within the filter."

This statement transcends the region of criticism, especially when it is coupled with the fact that Mr. Scott-Moncrieff has repeatedly affirmed that in his experiments the whole of the suspended and soluble organic matter present in the sewage and absent from the effluent had been converted by the bacterial operation, and that no accumulations existed.

Dr. Reid declares himself to be optimistic. It should not

be forgotten, however, that the optimism and over-confidence of the enthusiast in sewage purification has previously and not infrequently led to no inconsiderable wastage of public funds, and to the grievous disappointment of the responsible engineer.

The Leeds experiments are of undoubted value as a record of careful and continuous work. They are of especial service in demonstrating the importance of the question of the suspended matter in sewage; in showing how very slow its disruption is; and in indicating that a large irreducible residuum always exists for ultimate removal and disposal. They are not so fortunate in having failed to recognise the importance which ought to be attached to the dissolved organic solids. Indeed, they assert that the dissolved impurities are oxidised by bacterial processes rapidly and easily, even during the time, three minutes, which the liquid took in flowing through the filter.

These and similar statements with regard to the dissolved impurities must, however, be regarded as assumptions, equally erroneous as those relating to the rapid oxidation of suspended organic solids previously animadverted upon. In neither case is there evidence in the effluent or elsewhere of the complete mineralisation of the suspended and soluble organic solids on the one hand, nor adequate expression of the oxidation of the organic solids in solution which have been removed by the filtration operation on the other.

This interpretation of sewage purification phenomena, though it is more in accord with the operations as ordinarily observed, has not, however, the merit of consistency, nor is it true.

If it can be shown that the organic solids in solution in the sewage, instead of being oxidised during the flow of the liquid through the filtration area, are in reality removed from the liquid as solid matter which is deposited upon the material in that area, then the importance of the original solids in suspension, which in the quoted Barking experiments amounted to 110 tons, cannot fail to be less momentous than those consecutively produced in the filtration area from the soluble solids, which were estimated to amount to 250 tons.

The Hampton doctrine is that the operation of sewage purification is one of desolution, that is to say, the impurities organic and some of the inorganic, whether in a condition of

suspension or of solution, are removed from the liquid by a process of precipitation. This theory, it will be seen, is the direct antithesis of that commonly held. The one involving a throwing out of solution, the other a liquefaction—a throwing into solution.

In a paper read before the Institution of Civil Engineers, in January, 1906, "On the Elimination of Suspended Solids and Colloidal Matters from Sewage," by Colonel Jones and Dr. Travis, the following conclusions are recited:

"The deductions drawn from the foregoing observations and experiments are: that sewage is, under all circumstances and at all times, completely clarified by the dissociation from the liquid of its organic, and some of its inorganic constituents, in a particulate condition, and not, as has been assumed, by the resolution and oxidation of such matters; and that the clarification can be, and is, accelerated in two ways, namely, by bringing the liquid into intimate contact with surfaces, as in land treatment and in filtration areas, and by movement of the liquid, as occurs in rivers into which sewage is discharged.

"Moreover, such effect can be delayed by quiescence, as was seen in the bottle observation first alluded to, where weeks elapsed before the liquid became transparent, or as would occur were the sewage to be ponded, and to remain undisturbed. On the other hand, the effect cannot be altogether arrested; it is a natural phenomenon."

These deductions, as stated, were, in the main, the result of observations and experiments conducted at the Hampton Sewage Works. Some of these experiments were incorporated in the paper, others were referred to in a paper in the Journal of the Royal Sanitary Institute for 1906, on "The Organic Colloids of Sewage," by J. H. Johnston, M.Sc., whilst there have been many others, including some in the course of operation which are reserved for a future contribution. Here it is only intended to give an interpretation of sewage purification phenomena based upon these observations and experiments, and to adduce evidence in support of it.

The interpretation is founded upon the following considerations:—

Sewage, as it arrives at the sewage treatment area, is a more ss turbid liquid, generally of a brownish mucilaginous

appearance, containing gross and fine matters in suspension. These matters can be arrested on ordinary filter paper, and are recorded by the sewage chemist as solids in suspension. The filtrate is described as containing the solids in solution, though if it be submitted to a refiltration, or to the operation of a finer filter, a further proportion of matters in suspension would be removed. Even after the double filtration, or other procedure, it not uncommonly happens that there would still remain particles in suspension which would follow ordinary gravitation laws and deposit. After the removal of these several solids—the real solids in suspension—the liquid contains infinitesimally fine particles, which are not subject to the above-mentioned laws, being in a condition of solution—colloidal. The particles are, however, definite, being capable of recognition by the ultramicroscope, and of determination in various ways. Moreover, there is no elemental difference between the particle in colloidal solution, and recorded as amongst the solids in solution, and a large proportion of the grosser particulations removed by the filter paper and recorded amongst the solids in suspension. At one time and in one sewage the particle may be in colloidal solution—hydrosol—whilst at another time, and in another sewage area, it may be in a condition of suspension—hydrogel. It is inconceivable, therefore, that in the one condition it can be completely oxidised in three minutes, and that in the other it can only be slowly acted upon, leaving ultimately a large irreducible residuum. More especially is this the case when it is remembered that the throwing out of solution is one of the characteristic properties of colloids generally, and that the condition of solution is dependent upon the continued maintenance of the binding force between the particle and the solution of the particle. When this is interfered with, a more or less immediate precipitation of the particles takes place. This precipitation—the aggregation and coagulation of the particles—can be seen under the microscope, and can be expedited in a variety of ways, amongst which the intimate contact with surfaces is a well-recognised means. This intimate contact is secured in filtration areas generally, and in this way the particles in solution become particles in suspension and are brought within the laws of gravitation. The result of this operation is to deprive the liquid of its colloidal matter and to bring it into a clarified condition. The liquid will, however,

still contain certain organic products which are capable of existence in true solution, in addition to ammonias, and inorganic soluble solids.

The above-described effects can be witnessed, when sewage is submitted to continuous observation in the laboratory under almost every conceivable set of practical working conditions. A sample so submitted will show: the immediate deposition of the grosser, heavier solids; the delay incidental to the dropping of the finer suspended matter; the earlier or later coagulation and deposition of the colloidal matters; and throughout all the gradual clarification of the liquid, which proceeds *pari passu* with the deposition effect. The complete operation will have resulted in the conversion of the turbid sewage into a clear liquid, by a transference of matters in solution to matters in suspension, and by the simple deposition of these, and of the ordinary suspended solids. The original solids in suspension will have become increased by the operation as the original solids in solution will have proportionally diminished, whilst the bulk sample will have remained practically unchanged as regards its total constituents. If the observation be further continued, the deposit will be seen to become gradually reduced in amount and to be changed in character, the viscous particles having assumed a more granular appearance. Soon, however, this reduction effect will become less marked, and finally will appear to be determined, whilst the liquid in the mean time will have continued clear. Even in samples which have been under observation for years there still remains deposit and clear liquid.

It must not be assumed that it is intended to convey the impression that the biolytic operation is restricted to the later series of phenomena, and excluded from the former. It should only be understood that the desolution effect has entirely overshadowed any reduction or other operation due to the action of organisms. It is recognised that biolysis occurs in the sewage prior to its having gained admission to the treatment area, that is to say, in the sewers, as well as in the alimentary tracts of the animal economies contributory thereto.

When sewage is admitted to a treatment area, the above described series of phenomena occur, and are of the essence of the operation. The phenomena, however, are obscured, to some extent, by the presence in the area of organic matters, organic

products, ammonias, nitrites, and nitrates, which have resulted from previous physical, chemical, and biolytical sewage operations. These substances—the majority of them—are undergoing some degree of change, and, as they contribute to the liquid as it passes through, of necessity alter it.

In tracing the sewage through a treatment area, it will be seen that, in passing through the screening and detritus chambers and septic, hydrolytic, or other tank, the sewage will leave behind the gross substances; the larger proportion of its depositing and floating solids; and probably some of its colloidal solids. Any biolytic change in the liquid itself or in the finer solids which it carries is practically negligible. The sewage is, however, modified by the contributory sources alluded to above. It becomes admixed with previous sewages; it is impregnated with gases and volatile products, and has added to it some increase of ammonias, and of soluble organic products resulting from biolytic changes in the sludge deposited from sewage, some of which will have been brought to the treatment area months before; and, in addition, it carries forward not only its own undeposited suspended solids, but also no inconsiderable quantity from the older sludge which has been disturbed by gaseous eruptions.

In passing through the filtration area, whether this area be contact beds, percolating filters, or land, the operation is practically alike in each, differing only in degree.

The suspended solids become, in part, arrested by the fineness of the pores, and by adhesion to the material, or to the slime covering the material from previous sewage operations. The colloidal matter of the solids in solution becomes particulate upon the material or slime, and adheres to it. Some proportion of the organic products which are in a condition of actual solution and some of the ammonias are absorbed by the material or slimy coating. Biolysis causes some portion of the organic products to be further reduced, and carbonic acid and other gases to be liberated, as well as some larger proportion of the ammonias to be oxidised. Some proportion of the gases, and volatile substances, to which the offensive odour is due, whether present in the original sewage or contributed to it from the accumulated sludge by the tank operation, will be given off into the atmosphere, whilst some proportion will become absorbed by the material and oxidised—sulphuretted hydrogen

being decomposed and free sulphur deposited in the filter, substituted ammonias being also decomposed, and the ammonias oxidised.

The effluent, thus deprived of its odour, may contain some suspended matter from the original sewage if the pores be open; it will almost certainly contain some proportion of colloidal matter which has not been removed from solution; some organic products and ammonia which have not been converted by the biolytic operation; and some oxidised nitrogen.

Its character, however, will be profoundly altered by the contributory sources. By admixture with the retained liquid, and whilst flowing over or in contact with the material and slime, the incoming liquid will have added to it suspended matters both actual and colloidal from antecedent deposited matters, as well as organic products, ammonia and oxides of nitrogen, the results of biolytic operations on the deposited and absorbed substances from previous sewages.

The relative apparency or obscurity of the operation is largely a question of size of material. In the finer experimental filters at Lawrence, where the applied sewage is only 4 per cent. of the liquid contents, and does not appear as an effluent for 25 days, the operation is obscure, and any doctrine formulated upon it is largely inferential.

In the larger grained experimental filters at Lawrence and Hampton, where the applied sewage appears as an effluent in a few minutes, the operation is apparent, and the interpretation is, or ought to be, easy.

In the "Thirty-fourth Annual Report of the State Board of Health of Massachusetts" (1902), Boston, 1903, pp. 202–3, analyses are given showing the results of working the intermittent continuous filters Nos. 135 and 136 for the year 1902. In the case of filter No. 135 the total suspended solids applied to the filter were 4·6 parts per 100,000, whilst the effluent contained 7·7 parts, so that neglecting any biolytic action upon the 4·6 parts, the operation had actually resulted in increasing the total suspended solids by 3·1 parts, or by 67·4 per cent. over that which had been applied. Where these additional suspended solids had come from is clearly shown in the analyses, for the organic solids in solution had, during the same period, been reduced from 16·2 to 12·0 parts per 100,000 in passing through the filter. The sum of the operation was that the total

suspended solids had been increased by 3·1 parts, whilst the soluble organic solids had been reduced by 3·8 parts. The figures relating to filter No. 136 similarly show that the total suspended solids had increased by 5·0 parts per 100,000, whilst the organic solids in solution had been reduced by 6·7 parts.

The experimental percolating filter at Hampton brings out these facts with great clearness. On this account, it has been arranged that it shall form one of the subjects of demonstration at the visit to the sewage works. The filter has applied to it the effluent from the hydrolytic tank, which has a mucilaginous appearance, containing, as the average of all the samples submitted to analyses, 7·4 parts suspended matter per 100,000, whilst the filtrate is only slightly opalescent and contains an average of 13·7 parts. This increase in the matters in suspension has been proved to come from the soluble organic solids, which, in passing through the filter, have shown a compensatory reduction.

The questions of methods of construction and of working also apply. If, for instance, it be thought desirable to retain the solid matters in the filter, as is somewhat usual, especially in the case of contact beds, the desolution effect is obscured. If, on the contrary, it be thought advisable to unload, the desolution is obvious.

The original method of working the Hampton contact beds was to exclude nothing from them, except the screenings, and to endeavour to retain the suspended matter in them, in the confident hope that all would be destroyed. The result was that, in 1902, after four years' operation, so much sludge had been removed from the beds, and so much was retained in them as to give rise to the opinion that the original suspended solids had either suffered no diminution by biolysis, or whatever diminution had been effected had been made up from some other source.

The opinion was confirmed by careful estimations and calculations which are referred to in a paper read before the Association of Managers of Sewage Disposal Works, at Hampton, on June 17, 1905, by Mr. T. Hughes, the manager, entitled "A Retrospect of Six Years' Treatment of Crude Sewage in Triple Contact Beds, and a Forecast," and also in the paper by Jones and Travis before referred to. Since these papers were

written the correctness of the calculations has been confirmed by estimating the total amount of sludge removed in washing the beds.

By the method of working the beds, the biolytic effect upon the original suspended matter had not been manifest, owing to the desolution effect occurring in them, whilst the latter effect was not evident in the effluent, and could only be inferred by the amount of accumulated matters.

The present method of working the beds is to exclude from them the largest possible quantity of suspended solids, and as much of the colloidal matter as will readily be removed from solution by large surface contact. Whilst at the same time the beds are so operated as to secure the disengagement and evacuation of as large a proportion as possible of those solids which have entered them, or which may be formed therein from the soluble solids.

By this method of working the desolution effect is made evident, since the total amount of suspended matter leaving the beds is in excess of those gaining admittance thereto. The effect of this throwing out of suspended matter is, obviously, to minimise the accumulations, which necessarily must prolong the working efficiency of the beds.

If the sewage, instead of passing through a treatment area, be discharged into a river, the same series of phenomena occur, excepting that they are spread over a greater distance, and may occupy a longer time. In this case the sewage, in being carried down the river, deposits its suspended solids and colloidal matters, whilst the liquid portion admixes with the river water, and those substances in actual solution—organic products and ammonia—are further broken down and oxidised. In so far as the liquid is concerned it has passed on clarified and purified. In so far as the important sewage impurities are concerned—the actual and potential suspended matter—they remain behind, forming a layer of deposit along the bed of the river. To this deposit each discharge of sewage adds its quota. The continuously increasing accumulations, besides being subjected to the operations of scavengers previously alluded to, are slowly reduced by biolytic—fermentative, putrefactive, and oxidative—actions. This reduction effect is largely a question of temperature. In the colder weather the slowness of the changes in the deposited matters permits the gaseous and

volatile substances to escape without disturbing the deposit, and to be themselves further broken down and oxidised, so that no external evidence of the fermentative and putrefactive nature of the operation exists. In the warmer weather, however, the actions are more energetic, the deposited matters become charged with minute gas bubbles, which, when failing to escape, float portions of the deposit to the surface, where the gases and volatile products are given off, and the putrefactive nature of the operation upon the actual and potential suspended matter is made evident to the senses.

This interpretation of sewage purification phenomena in rivers is in direct opposition to that propounded by Mr. Dibdin. He believes that "from the work done on the sewage of London the conclusion might be drawn that the whole of that sewage was being destroyed by aerobic bacterial action," and has stated that the aerobic bacterial theory of sewage purification was deduced from those observations.

The essential nature of the operation, however, does not admit of any doubt. An examination of the deposited matters on the bed of the river will demonstrate the complexity of the biolytic actions, and will verify the axiom that putrefaction of nitrogenous organic matter is as inherent a part of nature's operation, as is the oxidation of the ammonia to which such action gives rise.

If further proof were needed, it could be found in the common observation that it is in the warmer weather, during the period of the greatest biolytic activity, that the putrefactive character of the operation is most in evidence, and that in the colder weather, during the organisms' practical inactivity, little or no such manifestation exists. Whereas in order to establish Mr. Dibdin's theory the exact opposite should prevail. The argument does not, therefore, require further elaboration, for such an interpretation bears its own refutation.

When the doctrine of desolution as an interpretation of sewage putrefaction phenomena was first propounded at Hampton, and after the colloidal character of a large proportion of the organic solids in solution had been determined, a search was made in the literature of the subject in order to ascertain if any confirmatory evidence of these views could be found. The references relating to colloids were given in the paper by Jones and Travis, and need not be further elaborated in this

communication, notwithstanding the fact that other papers dealing with colloids in sewage have since appeared.

It therefore only remains to adduce evidence in support of the theory of desolution.

In 1900 Professor Dunbar, Director of the State Institute of Hygiene, Hamburg, announced that, as the result of many years' experiments, he had come to the conclusion that the explanations made with regard to the purification of sewage in oxidation beds, viz. that such purification was directly and completely due to bacterial action, was wrong. He pointed out, and adduced numerous experiments to prove that the principal part in the process of purification was played by absorption action, but that the effective continuance of the absorption action was directly dependent upon bacterial activity and oxidation.

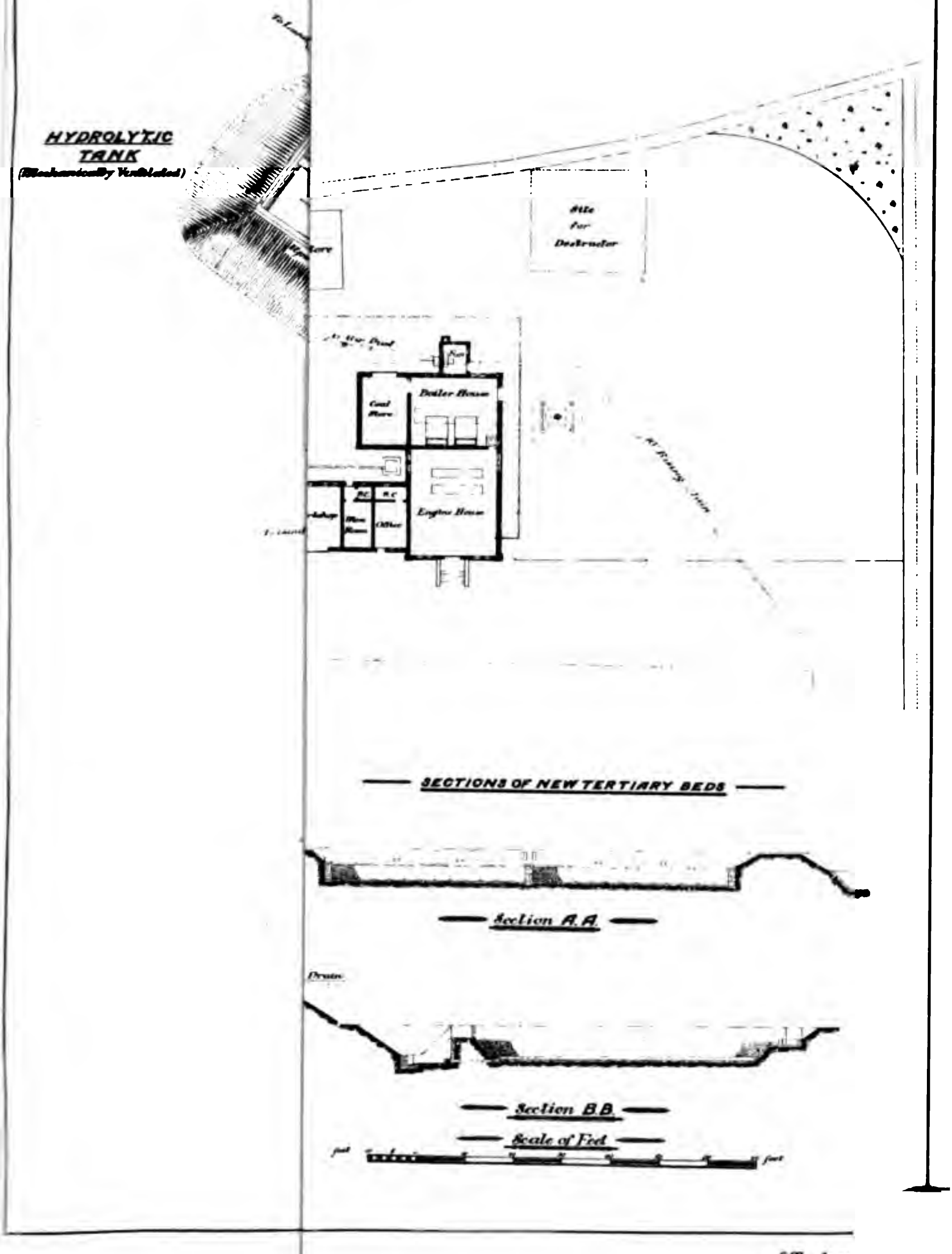
Since that time the subject has been continuously investigated at the State Institute under the direction of Professor Dunbar. One of the results of these researches is a communication by Drs. Kammann and Carnwath, a condensed transcript of which, by J. H. Johnston, M.Sc., appeared in the *Surveyor* on the 27th ultimo, and from which the following extract is taken:—

"The sewage, with its dissolved organic matter, after the suspended matters have been retained by mechanical filtration on the surface of the filtering material, is divided into very thin films between the single particles in the fine sand. Around each single grain of the filter forms with time a very thin, soft membrane, which is made up of undissolved matter of an organic and inorganic nature, and tends to raise not inconsiderably the original water-retention capacity of the material. Peculiar to this sticky coating is the formation of quite an enormous surface, which consists not only of an outer, but also of an inner, moistenable surface; and to this also is to be ascribed the high development of the absorption action to which we must necessarily attribute the explanation of many actions observed in biological sewage purification processes.

"The dissolved organic matter of the sewage applied to the filter is absorbed by the moist membrane. In artificial biological processes the absorption is completed in three to ten minutes; so that with the far greater surface development of a very fine intermittent filter, and the accompanying better division

PLATE NO. 1.

LAN.



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of the sewage into very thin films, a still quicker absorption of the dissolved organic matter of high molecular weight is to be supposed. Only in this way is it explainable how sewage applied to a filter in a very short time flows away from the effluent channel deprived of its organic putrescible substances as a clear, bright product.

"The filter has now a rest, the absorbed organic matter is decomposed in the moist membrane by the action of micro-organisms, enzymes, and absorbed atmospheric oxygen, and the nitrifying bacteria begin their action of mineralising, simultaneously with chemical oxidation, the nitrogenous organic matter lying in their sphere of action. This biological action, coupled with chemical energy, goes on so long as there are any substances of high molecular weight still to be broken down."

Professor A. Calmette, Director of the Pasteur Institute, Lille, has this year published a paper in the *Revue d'Hygiene*, "On the Mechanism of Biological Purification by Contact and Percolating Beds," from which the following is extracted:—

"Every one knows that when sewage filters through a soil sufficiently permeable and conveniently drained there is seen to issue from the drains a clear water, whose purity is quite comparable to that of streams and rivers the most protected against accidental causes of pollution. Thus the soil has absorbed and retained the impurities, as if it had dissolved them.

"This phenomenon of absorption was observed for the first time a hundred and fifty years ago by an apothecary named Bronner, again in 1819 by an Italian agriculturist, Gazzier. Thirty years later it was discovered anew by Huxtable and Thomson. These scientists remarked, on shaking manure water with earth, that this earth absorbed the organic matter, leaving the manure water decolourised and clear.

"If, then, one filters through earth a solution, of purine for example, each of the elements of the earth fixes the dissolved matters as by a phenomenon of adhesion or of dyeing. Each element impoverishes the solution during passage, and it is soon deprived of all the organic matter which is susceptible of being fixed. The length to which this purification goes varies with the depth, the absorbing power, the hygroscopy, and the temperature. It varies also with the richness in organic matter of the water applied, and according to the nature of this matter. Those which are the most complex, and the nearest to the

vegetable or animal state, are the most actively fixed. The power of adhesion diminishes as the molecule is simplified: it is *nil* with certain crystallisable substances."

"The researches of Dunbar have thus established the following theory of purification in bacterial contact beds. The matters in suspension are arrested by the beds; the matters in solution are fixed by an absorbing power analogous to that of soil. During the periods of aeration the microbes decompose the fixed matters and regenerate the material by permitting a new fixation."

It is not necessary, neither is it intended, to comment upon these confirmatory illustrations, other than to say that the quoted authorities fully recognise the fact that the organic solids in solution are not mineralised during the transit of the liquid through the filtration area. They do not particularise the colloidal state in which these solids exist in the sewage, but in describing the method of removal from the liquid in its passage through the filter as a fixation upon the material by a process of absorption or dyeing, and in showing that this power increases with the complexity of the organic molecule, they infer its colloidal nature, and the phenomenon a desolution. The question as to the immediate or remote, complete or incomplete biolysis of the matters so fixed does not arise in this connection, even had it not been previously dealt with.

In conclusion, the Author desires to express his great indebtedness to Dr. Travis of Hampton for permission to utilise his "Notes on Experiments" and other writings, which the Author acknowledges having taken full advantage of. The Author's obligations are also due to Mr. J. H. Johnston, chemist, and to Mr. T. Hughes, manager of the Hampton Sewage Works, for other valuable assistance.

AN ADDENDUM RELATING TO PUBLIC WORKS RECENTLY CARRIED OUT AT HAMPTON-ON-THAMES.

THE Association has on a previous occasion (in October, 1900) visited this district, when the Author's predecessor, Mr. John Kemp, Assoc.M.Inst.C.E., read a paper on the Sewerage and Sewage Disposal Works with reference particularly to the Shone system of collecting and delivering the sewage; the construction of the works departmentally, and to the working of the bacterial method of treatment by triple contact; which paper is recorded in the "Proceedings of the Association," vol. xxvii. (1900–1901), p. 97. It is not, therefore, proposed in this reference to traverse the same ground, but to describe as briefly as possible the extensions to the Sewage Disposal Works, and other works that have been carried out by the Author.

EXTENSIONS TO SEWAGE DISPOSAL WORKS.

In 1903, owing to the difficulties incidental to the passing of a screened sewage direct on to contact beds, now well understood, and on account of the increasing volume of sewage arriving at the Works from the growing population, it was found necessary to provide more suitable means for efficiently removing the suspended matter from the sewage. The Author, in conjunction with the Consulting Engineers, advised the Council to instal the Hydrolytic Tank, and after having received the necessary sanction of the Local Government Board, the work was put in hand and carried out departmentally under the direct supervision of the Author.

The existing screening chamber into which the whole of the sewage is delivered from the rising main was raised 18 inches. This chamber was formerly open, but objectionable odours were

emitted into the atmosphere, due to the fact of the sewage having been in the rising main for a long period, and it was decided to cover and ventilate the chamber as part of the scheme for the general ventilation of the tank, and closed channels on the principle of the Hydro-mechanical system of sewer ventilation.

The sewage passing through the screen is conveyed by a covered channel to the detritus tanks. These tanks are in duplicate and are worked alternately. Each has a capacity of 3000 gallons. The sewage is diverted from one to the other about once a fortnight, and the sludge is removed from the full tank by means of a valved opening, which allows it to pass into the sludge manhole. By this means nearly one half of the total quantity of sludge is removed from the sewage. From these tanks the sewage enters the centre of a transverse channel which conveys it into the sedimentation chambers of the hydrolytic tank by delivering it behind submerged walls which lead it to a depth of 4 feet 3 inches. This tank is divided by light walls formed of 4-inch self-faced York flagstones, into three compartments, the centre one of which is the reduction chamber, the outer two the sedimentation chambers; the only means of communication between these chambers being by narrow openings at the bottom of the sedimentation chambers. At the end of the tank is a weir divided into three portions, one for each chamber; the relative widths of these divisions govern the outflow of sewage from the several chambers, and determine the proportional quantity which flows through each. The side weirs (sedimentation) have a width of 7 feet each, or a combined width of 14 feet, and the central (reduction) weir has a width of 2 feet. The total width of 16 feet is, therefore, apportioned in the ratio of 87·5 per cent. to the sedimentation chambers, and 12·5 per cent. to the reduction chamber.

The tank was designed to deal with 300,000 gallons per day, but it has been amply demonstrated by experience with the tank, and by experiments in the model tank, to be capable of dealing efficiently with a dry-weather flow of 500,000 gallons per day.

While the sewage passes through the sedimentation chambers, those matters in suspension whose specific gravity approaches to that of the liquid will travel along a practically level plane, while the lighter and heavier particles will describe upward and

downward curves, the length of the curve being proportioned to the weight of the particle and the velocity of the flow. The lighter particles will rise to the surface and be retained there by the submerged walls at the end of the chamber. The heavier particles, in falling, have their curve shortened by the descending volume of the liquid which passes out of the bottom of the sedimentation chambers into the reduction chamber; in other words, the natural downward displacement of the particles will be accelerated by the downward flow of one-eighth of the entire volume of sewage, by which means the deposit is carried into the reduction chamber. The slower rate of flow in this chamber permits the solids to descend into the lower part of the chamber and prevents so large a quantity of the deposited matters from being carried out of the tank during periods of agitation caused by the gases generated.

The formation of gases is, with almost negligeable exceptions, limited to the reduction chamber, and the evolved gases rise to the surface of the liquid either directly or by being directed there by the sloping walls. These walls separate the rising gases in the reduction chamber from the depositing solids in the sedimentation chambers, and thus obviate the confusion in operation which would otherwise ensue. The part of the chamber below the openings at the bottom of the sedimentary chambers is for the reception of sludge; it is designed to hold the sludge contained in forty days' average flow of sewage. In actual work, however, it holds double this quantity. Along the floor at intervals are fixed valves, through which 3000 gallons of sludge are removed about once a fortnight from the tank into the sludge manhole.

The floating solids on the surface of the liquid in the sedimentary chambers and those floated in the reduction chamber are occasionally, when unduly accumulating, raked over into the detritus tank.

The sewage flowing over the weirs of the first portion enters a channel which leads to the second portion of the tank. This consists of four hydrolysing chambers, arranged in sequence. The liquid is conducted to the bottom of each chamber by means of stoneware pipes. Blue brick arches are constructed to support the material, and arranged with 2½-inch openings, so as to leave passage for the liquid. The floor under each arch is concave, and forms with the arch a space for the sludge; two

valves are provided under each arch for the removal of the deposit. The material is broken flints, varying in diameter between 3 and 6 inches. The liquid passes upwards through the openings between the bricks and through the material to the surface, where it flows over a weir, and enters the downward stoneware pipes of the next chamber. After the operation has been repeated in the four chambers, the liquid, having taken three hours in its passage, enters the lower covered channel which conducts it to the contact beds.

The ventilation of the tank and channels is effected by means of an 18-inch "Sirocco" fan driven by a Marshall's vertical steam-engine, which causes a diminished air pressure in the air duct, channels, and tank, and withdraws the gases as they rise to the surface of the liquid. Atmospheric air is admitted at various regulated openings as indicated upon the plan. The chief opening is situated near the end of the effluent channel, which ensures that the maximum quantity of air shall pass over the surface of the liquid after it has left the tank. This volume is increased in the tank by the air admitted at the several regulated openings. The increased volume passes over the surface of the liquid in the tank, and over that in the channel and screening chamber, to the air duct and fan, whence it passes to and through the air purifying filter fixed over the fan-house, and is discharged therefrom into the atmosphere. By these means the gaseous contents of the tank and channels are rendered practically inodorous. On the other hand, gases which have been formed in the rising main and tank cannot escape out of any of the openings leading into the screening chamber, tank, or channels.

The sludge removed from the detritus tanks, the hydrolytic tank, and the hydrolysing chambers, passes into a 50-gallon Shone Pneumatic Ejector, which discharges its contents into trenches in the land. These trenches are 3 feet wide, 1 foot 6 inches deep, and 120 feet long, a space of 5 feet being left between each pair of trenches for future utilisation. Half an acre will suffice for twelve months' sludge disposal, which is at the rate of 2 acres per 1,000,000 gallons of daily flow of sewage.

At the present time, and for the past eighteen months, the primary and secondary contact beds have been fed from the bottom, that is to say, the liquid from the tank is discharged from the covered channel into a shaft which is connected to a

main duct, having communication with the half channels formed in the floor of the beds, and covered with an earthenware perforated tile, thus enabling the liquid to be distributed over the whole filtration area. By this method, undoubtedly, distribution and aeration are carried on more uniformly, whilst at the same time, owing to the action of the upward and downward flow, and the beds being emptied with valves full open, the beds are more completely deprived of their accumulated matters, and therefore maintain their original capacity for a longer period.

The effluent from the primary and secondary beds is discharged on the surface of the tertiary beds, the top layer of which consists of some 12 inches of very fine material, that enables the sludge and other deposited matters to be retained on, and easily removed from, the surface.

The cost of these extensions has been as follows:—

	£
Hydrolytic tank. Detritus, sedimentary, hydrolysing chambers	2200
New channels. Alterations to, and covering of old channels. Raising and covering screening chamber	150
Ejector, chamber, air and rising mains	300
Engine, fan and fan-house, and air ducts and filter	300
Total ...	£2950

In February last it was found necessary to increase the area of tertiary beds, and the Author constructed departmentally two additional beds with an area of 257 sup. yds. each. The cost, which was borne out of current rates, amounted to 365*l.*

Rosehill Estate.

The Council in 1901 purchased the Rosehill Estate, containing an area of 4 ac. 0 rd. 33 p., for the sum of 3300*l.*, and a mansion, which has been adapted for the public offices, library and reading-room, and technical classes; about $\frac{3}{4}$ acre has been set apart and enclosed as a depôt, the existing stables, coach-house, and sheds on this portion being utilised for present use. Some $2\frac{1}{4}$ acres were allocated for a Housing Scheme.

HOUSING SCHEME.

During the year 1902 the Council carried out the scheme for housing the working classes, which the Author prepared and supervised.

The following statement, together with the plans, set forth the details :—

WORKMEN'S DWELLINGS.

(*Erected under the Housing of the Working Classes Act*, 1890.)

PARTICULARS OF DWELLINGS.

The dwellings are divided into four classes as follows :—

12 cottages (Class A), each containing	5	rooms	and a	scullery.
30 " (Class B) " "	4	"	"	"
5 " (Class C) " "	4	"	"	"
9 double tenements (Class D) "	2	"	"	"
1 old cottage (South Lodge) "	4	"	"	"

Each tenement has its own larder, coal-store, and w.c., and a garden at the rear averaging about 80 sq. yds.

The area of the site utilised is 1 ac. 3 rds. 11 p.

The scheme was completed in September, 1903, and comprises—

	Frontage.	Rent.	Cubical contents.	Cost per house (building only).	Cost per foot cube
	ft. ins.	s. d.		£ s. d.	d.
10 cottages (Class A)... ...	12 6	6 9	8,561	219 16 8	6·16
2 end houses "	23 4	7 0			
29 cottages (Class B) ...	12 6	6 3	7,951	194 6 8	5·87
1 end house "	22 6	6 9			
5 cottages (Class C)... ...	16 6	7 0	9,727	250 12 0	6·20
9 double tenements (Class D)	17 6	4 6 ground floor; 5 6 first floor	12,656	295 6 8	5·6
1 old cottage (South Lodge)		5 6		150 0 0	

All rooms have a clear height of 9 feet.

The total cost of the scheme, inclusive of supervision charges, is as follows :—

	£ s. d.	£ s. d.
Land: 2 acres 0 rd. 38 p. at £451 14s. 1·6d. per acre	1,010 0 0	
Cottage (South Lodge)	150 0 0	
		1,160 0 0
Buildings	12,399 16 11	
Roads, drainage, and sewers	841 0 0	
Fencing	534 0 0	
Other expenses	462 14 6	
		14,237 11 5
		£15,397 11 5

£1,160 was borrowed for 50 years, interest at 3¾ per cent.
£14,237 „ „ 40 „ „ 3½ „

Infectious Diseases Hospital.

In 1903 the Author prepared plans, etc., and superintended the erection of a four-ward isolation hospital, with a total accommodation of 10 beds, which comprises the following buildings:—

Administrative block.
Ward pavilion.
Laundry and disinfecting block.
Ambulance station and mortuary, and recently has been added porter's lodge and discharging block.

The buildings were designed and the site laid out in accordance with and in strict adherence to the Local Government Board's regulations in such matters.

Total Expenditure incurred.

			£
Land: 7 acres (2 acres only are at present utilised and enclosed)			2061
Buildings, etc.	£3464		
Porter's lodge and discharging ward	498		
		£3962	
Furnishing (including tent, etc.)		384	
Laying out grounds		100	
			4446
Total ...			£6507

Tramways.

The London United Tramways Company, Ltd., obtained powers from Parliament in 1898, and in 1902 constructed tramways through the district. There are 2⅓ miles (double

track) and a short length of single track at High Street, Hampton Hill.

The original Act contained very few concessions in the way of widenings and improvements, but during the construction and afterwards the Council have very successfully obtained further concessions from the Company, so that, when the Company have fulfilled all their obligations, which, by the way, they appear to be very slow in accomplishing, nearly the whole of the route traversed will have been widened to 45 feet or more, besides the footways paved and kerbed and the road properly drained.

Many notable and costly widenings have been made, and owing to the existence of the large trunk mains of the Metropolitan Water Board, which in some instances were only a few inches below the surface, and had to be lowered or the road surface raised, there is no doubt that this portion of the service has proved to be the most expensive to construct.

Electric Lighting.

This work has been carried out in the district by the Twickenham and Teddington Electric Supply Co., to whom the Council leased their order, which they obtained in 1901.

The Council may determine the agreement of 1903 by twelve months' notice to expire at the end of the first seven or fourteen years, or at the end of any year subsequent, or by mutual consent at any time by paying the Company the amount of capital actually expended by them on lands, buildings, works materials, and plant within the district plus 15*l.* per cent.

New Bridge.

After much consideration the London and South-Western Railway Company were prevailed upon to construct a new bridge at Park Road in 1905 in place of an old wooden one.

The total cost, including approaches, amounted to 2570*l.* The Council have to pay a moiety of this amount in 20 equal half-yearly payments with $3\frac{1}{4}$ per cent. interest on the sum remaining unpaid.

Private Streets.

Recently a number of streets have been made up under the Private Street Works Act, 1892, and the cost of the last four is as follows:—

	Width.	Total cost.	Rate per foot run of frontage.
		£	s. d.
Buckingham Road	40 feet	3642	10 5·32
Park Road	50 "	1035	12 7·1
Acacia Road	40 "	1139	9 3·12
Nightingale Road	40 "	841	9 2·37

Refuse Collection and Disposal.

The refuse is collected once a week from every house, and the whole of the work is completed in four days. This work was reorganised some three years ago with very satisfactory results, the present cost is some 340*l.* per annum, and only 9*l.* more than it was nine years ago (when the collection was fortnightly), although the number of houses has increased some 44 per cent.

The method of disposal that is still in vogue is by filling up disused ballast pits. The Author in 1904 advised the Council to adopt a more sanitary and up-to-date system, and after many inspections, meetings, and reports, the Author was instructed early in this year to prepare plans and specifications giving the necessary details to enable the several makers of refuse destructor plants to submit schemes for destroying the refuse and utilising the waste gases to generate steam to drive the machinery at the air-compressing station. Tenders have been received, and the Council have decided to accept the tender of Messrs. Horsfall, their price being the lowest, viz. 1211*l.*, which includes two cells, grate area 30 square feet per cell, front feed type, combustion chamber at right angles to the furnace, Cornish boiler 16′ 6″ by 6′ 6″ in diameter, with a working pressure of 120 lbs. to the square inch, forced draught by means of fan and steam jets, Cameron type feed-pump and self-acting injector, dust catcher, and no doubt an air heater will be added. The total cost of the scheme is estimated at 2500*l.*, which includes

buildings, main flue to existing shaft, and steam connections. The Author is of opinion that the scheme should not be a charge upon the rates, after due allowance is made for the saving in the coal bill and value of residuum.

STATISTICS.

	1891.	1901.	1907.
Population ...	5,882 ...	6,813 ...	9,500
Rateable value ...	£59,852 ...	£80,584 ...	£124,000
Death-rate ...	14·3 ...	10·6 ...	10·5 (per 1000)

Area: 2036 acres.

General district rate ...	1*s.* 7*d.* in the £.
Poor rate	1*s.* 7*d.* in the £.

The total indebtedness of the district is 74,151*l.*, which includes 14,347*l.* for the Housing Scheme, and 6511*l.* for Private Street Works, the principal and interest of these not being paid out of the rates.

ROAD MILEAGE.

	17½ miles maintained by the Council.
	2¼ " " " County Council.
	3¼ miles private streets not yet taken over.
Total ...	23¼ miles.

The Author cannot complete these notes without expressing his deep gratitude and thanks to all those who have rendered him assistance in the arrangements for this meeting, especially to the Clerk to the Council, Mr. Edgar Cozens, and Mr. W. B. Smith, Assistant Surveyor.

DISCUSSION.

Mr. C. H. COOPER: I beg to propose a hearty vote of thanks to the Author. I am not very much in favour of septic action, but there are, no doubt, cases where it may be made use of, as in sewage disposal there is no one method of treatment applicable to all places. As regards public work, I am glad to see Hampton adopting the principle of doing work departmentally. I find it very good in my own district, but of course you do find places where the method has utterly failed. I do not think you can find a worse failure of departmental work than

the Metropolitan Water Board. I will take, as an instance, the fixing of fire hydrants. Formerly in Wimbledon we were able to get our fire hydrants fixed at something under 8*l.*, now I am unable to estimate what will be the cost. In a case the other day of a new estate where the hydrant was fixed when the main was laid, the Metropolitan Water Board charged something like 9*l.* If those hydrants were fixed in an ordinary street, where the main had to be cut, the cost would be 10*l.* The Board charges in each case a full day for a horse and cart—even though three or four jobs are going on close by. If a joint is made, the plumber's walking time, etc., is charged. The way in which the Board is managing its works department wants thoroughly overhauling, so that local authorities may be fairly dealt with.

I see Hampton has a contract with the Twickenham and Teddington Company as regards the electric lighting. I am afraid, for a district like Hampton, electric light is the most expensive form of street lighting. In a big town it is all very well, and I quite approve of it in main streets where there is a lot of traffic: but with outlying streets by all means adopt gas. You will get gas companies to supply the gas and maintain the mantles for 2*l.* 17*s.* 6*d.* per annum, and in some districts even find the lanterns. That is for all-night lighting. Electric lighting in my own district costs no less than a rate of 4¾*d.* in the £ per year. I should strongly advise a district to think twice before adopting electric light for street lighting. Mr. Chambers has gone very fully into the question of sewage treatment; and he has not advocated filters that deal with an abnormal quantity of sewage; he mentions 500 million gallons per acre in three years. We are glad to have figures which one can take as reliable.

Dr. S. Rideal: I have pleasure in seconding the vote. I am here as a visitor, and should have liked to have heard the views of the members before speaking on this practical solution of the sewage problem. This paper of Mr. Chambers' seems, perhaps, to be more theoretical than practical, as he has gone over the very latest theories in respect of sewage disposal. The point which is now under discussion in the theory of sewage disposal, and which has been elaborated by Mr. Chambers, is whether the matter which undergoes treatment in any sort of area is first brought out from the colloidal state into a solid

condition before undergoing further change. The advocates of the colloidal theory, as represented here by Colonel Jones and Dr. Travis, maintain that before any real change takes place in the liquid portion of the sewage passing through the hydrolytic tank—the organic solids in solution are changed into a particulate condition, and that this solid state is brought about by contact with surfaces. They further contend that this change is due in some way to the absorption phenomena which were shown by Professor Dunbar, of Hamburg, to always take place in sewage purification. Those who hold this theory, viz. that this is a purely mechanical or physical change, and has nothing to do with bacteria, are at variance with those who hold that the change is bacterial. Mr. Chambers, in his paper, admits there is a biolytical change in sewage, but wishes us to believe that this is subsequent to the physical phenomena which destroys the colloids present. Whether the sewage be put on land or in a filter, it there is finally oxidised by bacteria is, I think, now universally admitted. The difficulty we have to meet is that sewage is, perhaps, the most complex of all substances, and the changes which take place must also be very complex. Mr. Cooper was talking of the microscope just now. This colloidal theory is far beyond the microscope. It requires the ultra-microscope to investigate it. As to what the ultra-microscope reveals physicists are not yet agreed, and we cannot follow this change of the colloidal matter into a solid state any better by this instrument. When this hydrolytic tank—which is now in practice, for its erection here at Hampton was approved by the Local Government Board—was invented by Dr. Travis and Colonel Jones, it was called a hydrolytic tank, because the changes were believed to be due to hydrolysis—which means the breaking down of compounds into smaller compounds by combination with water without any oxidation or other change taking place. This change takes place in a variety of organic substances and in a variety of ways. We can, for example, convert a colloid substance like starch into a less colloid substance like dextrine by heat or by enzymes. We can also bring about that change by means of yeast. After the starch has been converted into dextrine, then, by after treatment, by any acid and warmth or bacteria you can convert this dextrine into sugar, which is crystalline or non-colloidal, and finally into alcohol and into

carbonic acid. That breaking down of the complex colloid of starch into the smaller compounds of dextrine, sugar, and alcohol is not accompanied by the formation of any particulate matter. This change of cellulose and starch into alcohol must take place in the sewage, and we have no reason to believe that in sewage the change is accompanied by the separation of any solid matter. That action of breaking down will take place in the brewer's mash-tun, and it will take place in the septic tank. You can take another substance—beef tea—which contains several complex colloid substances called albumoses. Those substances, by means of bacteria and acid, undergo a breaking down into smaller compounds without the formation of any solids, which are more easily filtered and oxidised. This peptonisation is determined by bacteria or their enzymes, by heat, but not by exposure to surfaces or contact with inert material like glass or clinker, and can be brought to the mineralisation stage without the separation of any solid. There is one example that we well know in which that is not true, where the colloid does not pass straight through to the mineralisation stage without the formation of a solid—that is the ordinary fermentation or souring of milk, and there may be others; but Dr. Travis and Colonel Jones say that all organic substances, before they are broken down, must become solid, and that is to be done somehow or other, but how we do not quite understand. It is rather remarkable that when I first published my book on Sewage Disposal in May, 1900, two months before I was engaged to write a book on glue, so that I was looking up all the information I could get on the typical colloid substance at the same time I was working at sewage disposal. When glue is diluted with water it also undergoes this hydrolysis. It breaks down into lots of small substances, and those substances have not the power of sticking as the glue does. In the ordinary glue-pot the change into a less colloid substance is brought about by hydrolysis without any solid particulate matter separating. This theory of sewage disposal has, however, some points in its favour. It is perfectly true that sludge is formed and separates when these changes take place. That was known at Hampton long before the hydrolytic tank and I believe was the primary cause of its introduction here. It is also known that in all percolating filters a black sludge is the final change. Whether that is due to

non-bacterial change or the converting of the colloid into these black substances by physical rearrangement of the molecules, as Mr. Chambers says, you cannot tell without the aid of the ultra-microscope, and the issue depends on the trustworthiness of this instrument. I think, however, the change is a bacterial one. In a paper read before the British Association, Section B, at Glasgow, in 1901, I gave some analyses of the Hampton black residues. The paper discussed the formation of humus and the so-called irreducible residue in bacterial treatment of sewage, and pointed out the similarity of peat and soil humus to that of the black substances formed in fermented sewage. Adeney, in 1897, had earlier called attention to this relation, but the following quotation from my paper, I think, shows that I then believed that these bodies were colloids and had the property of absorbing out of the liquid some of the organic soluble constituents:—

"Organic decompositions, except those of final oxidation, are usually attended by the production of a brown colour; the colouring matter sometimes remaining in solution, and sometimes in the more energetic reactions separating in brown flakes. Types of reactions producing the colour are:—

1. Heat alone, as in the formation of caramel from sugar and its allies.

"2. Heating with acids, alkalies, various salts, or even to a high temperature with water alone.

"3. The change that occurs when vegetable tissues are injured or exposed to air, as seen when fruits are cut or bruised, connected with the action of the ferments called by Bertrand 'oxydases.'

"4. Natural decay in the formation of soils, vegetable mould, and peat, and finally, under certain conditions, of lignite and coal.

"Simultaneously with hydrolysis a smaller number of molecules seem almost invariably to undergo the opposite change of withdrawal of water, accompanied by increase in the percentage of carbon, and condensation of the molecule producing coloured colloid compounds, which are comparatively inert, but have the power of combining with, or mordanting, large quantities of the matters in solution, both inorganic and organic. It is probable that the molecular weight of these bodies is exceedingly high. Their separation and purification is

so difficult that, in spite of a large amount of work, it has not yet been satisfactorily accomplished, but many common properties besides colour render it convenient to group together under the aggregate term humus all bodies possessing such properties and produced by dehydration with limited oxidation."

I believe, therefore, that the particulate matter is due to some product of bacteria which exist in the solution, and may be, if I use a very inaccurate word to express my meaning —their excreta. In the splitting up of these this black substance is produced, and more is produced under some conditions than others. Surfaces play an important part on absorption. They absorb much as the jelly-fish does its food, or the white corpuscles in the blood absorb bacteria. This surface growth envelops the small organic particles which then undergo digestion in the slime on the top of the bed, but to call that a physical change is perhaps as difficult to establish as the purely bacterial—the enzyme theory. There are very remarkable practical results put forward as the result of the working of this tank and filter. Mr. Chambers points out that in the experimental filter the amount of sludge which comes away is greater than the amount of sludge that goes into the bed. That is an argument for believing that the colloid matter in solution comes out of solution and accounts for the increase of sludge in the filter in the way I have just described. I do not know any other place where that has taken place to such an extent as in the filters here. The increase of sludge in suspension is thus novel. We know that solids do come out of all the beds, and are large in amount, and must be provided for, but I have never heard before of their being greater in amount than the solids going into the bed. Anyway, that is not a filter I should recommend you to go in for if you want to minimise the difficulties at your sewage disposal works. I think this hydrolytic tank should be renamed, and they ought to call it a non-hydrolytic tank or a colloidal tank, because if there is no hydrolysis taking place it is a misnomer. As I said at the beginning, we are discussing a very complex subject, and I regard the paper rather as a theoretical than a practical one.

Lt.-Colonel Jones, V.C.: I am very pleased that we have Dr. Rideal's company to-day, as he has given us such an extremely scientific and elaborate description of the very complex matter of sewage and its transformation. It is a

great pleasure to me to find that he has taken up the gauntlet thrown down by Dr. Travis and myself in January, 1906. Since that time a great deal of additional information has been stored up at Hampton by Dr. Travis, and through Mr. Johnson's careful observation of the hydrolytic chamber and model that he has at work. Not being a chemist by profession, what little I know of it is a smattering compared with Dr. Rideal, and I would not presume to speak on it in his presence, but I feel there is a practical aspect which ought to be interesting to us as engineers. Dr. Rideal has not taken the trouble to read carefully what this paper puts forward. We contend that the glue or the colloidal matter of sewage must be put into a solid form before it is acted upon by any bacteria. What Dr. Rideal asserts is exactly the reverse of what we have said, and what Mr. Chambers has put forward in this paper as the Hampton system. The Hampton system is exactly what the late Dr. Tidy did in the witness-box when he was called upon to give an example of precipitation, and insisted upon shaking the bottle. The same effect—the agitation in the presence of the solid substances—promoted the coagulation in the solution. That was taken advantage of in the hydrolytic tank by the many vertical surfaces. The German and English chemists are coming to see that there is a great deal in that, and it is more simple if you have got a substance like sewage not to dissolve it more in the septic tank, but to take out what is in a semi-solid state already by giving agitation in the presence of surfaces. I will say this—the very name contact bed realises this idea, that the medium and its surfaces were required, and they called it a contact bed in consequence. I dare say my reputation as a confirmed sceptic led people to jump to the conclusion, and I was taunted at Westminster and elsewhere as one who held that the bacteria had nothing to do with the purification work. On the contrary, I was one of the first (when Warington's discoveries came out that the bacteria worked in the land to purify sewage) to see the effect of these bacteria, but I impugned them by saying they were not immaculate, and did not do all they were said to do. They do their part. The great point arrived at lately is that, do what you will, these contact beds, or percolating filters, or whatever you like to call them, retain organic matter, and do not mineralise it in three minutes as they are supposed to do

by some people. My belief in sewage treatment from the beginning has been that you have got to follow the lines of nature. That what is cast off as excreta and dead from animal and vegetable life has got to go through the mill again, and be broken up in some way by the bacteria. We ought to respect that law of nature, and instead of trying to store sewage up in a small space we have got to spread it and pass it round. The whole thing is a course of nature, and works round and round.

Mr. A. E. Snape: A scheme similar to this at Hampton, in which the Hampton results have been taken full advantage of, has just been started at Norwich. The reason Mr. Collins has adopted that view is that we have got a large area of land which has got very sewage sick. This is thought to be due to the deposition of solids in the land, choking it up as in an ordinary filter bed. By adopting these tanks, which all are agreed are very efficient in taking out the solids from the sewage—no one has denied, after Mr. Hughes' paper, their efficiency in taking out the solids in the colloidal tank—we shall have a clear effluent which we can put on the land. Then, if the land treatment is not quite satisfactory, it is proposed to have filters to further purify the sewage. When one considers that at the present time tank after tank and filter bed after filter bed are becoming choked up, I do not think any one can deny there is something to be said for this hydrolytic tank, and the taking out of the solids. It is with this idea that these hydrolytic tanks have been put down in Norwich, and we hope in time to have some results to show the Association. The tanks are much larger than the tanks at Hampton, and we hope in time to get some results to support or carry further this very interesting problem of the disposal of sewage.

Mr. R. Aglio Dibdin: I am sorry my father (Mr. W. J. Dibdin) is unable to be present to-day. There are one or two places in the paper where Mr. Dibdin's name is used. I am sorry to say that in one place he is accused—under a misapprehension—of having recanted from the opinion that the natural inoffensive destruction of organic matter is due to aerobic biological activity. I venture to say my father is now, as ever, a very strong believer in the efficacy of biological action. In the first place, when his attention was drawn to sewage disposal as affecting the sewage of London, he observed

under certain conditions the disappearance of the solid matters as well as of the matters in solution. On the banks of the Thames the solid matters were deposited by the crude sewage going into the river. As long as the supply of sewage matter to that area was kept within certain limits, there was no sign of fæcal contamination on the foreshores, but when the amount of sewage sent into the river was greater than the natural forces at work in the river could overcome and destroy, then there were signs of fæcal contamination. When chloride of lime was used to disinfect the sewage, it destroyed the natural forces, viz.: the organisms, and there was a deposition of dead organic matter. When the effect of the chloride of lime passed off, and the natural forces began to act on the dead organic matter there was an offensive decomposition. It is rather late in the day to have any doubts as to the ultimate part which organisms play in the destruction of sewage. If, as Colonel Jones contends, we must accept the biolytic action which takes place in the human organism, then we must accept the biological action which takes place in the land through the lower animals, such as worms and beetles. The bacteria only play the lowest and least part in the destruction of this matter, and prepare it as manure for future operations. If we refer to the report of the evidence given before the Royal Commission on metropolitan sewage, you will see that the manurial value is insignificant—that it is not worth handling. Instead of trying to use the sludge it is more economical to change the solids in solution and suspension into such a form that there is no offence to human beings, and leave the utilisation of the substances entirely to nature. Mr. Dibdin's early experiments with filters showed that the bacteria mostly would grow; other organisms were few in comparison. The coarse primary bed was added to tackle the sludge; the solid matter as well as the fine matter. In a paper by Dr. Fowler before the Society of Chemical Industry it was shown that the absorption of ammonia by a filter is not necessary to nitrification, although such absorption is beneficial in the early stages when the bacteria are presumably few. The slime on the surface of the filter is biological in character, and the matters attracted thereto by physical causes are altered in character by organisms so as to become inoffensive. According to the nature of the outfall the chemical constituents of an

effluent are more or less of a secondary consideration, the main point being whether those constituents are so combined as to be harmless to men and animals, or are live matter of an inoffensive type. Mr. Dibdin has in no way recanted or withdrawn from his original ideas on these points. He has developed his ideas along certain lines. The slate bed, which is referred to as a means for treating solids, was designed primarily for increasing spaces. In order to use contact beds at such a rate that they would not be choked by solids, we should have had to multiply them perhaps two or three times. In order to overcome that difficulty, Mr. Dibdin devised the slate bed to give greater working capacity. The slate bed is nothing more than an irrigation plot, with surfaces one above the other. We have a series of surfaces which are comparable to the surfaces of irrigation plots covered with live earth containing the organisms found in good soil. We can allow a deposit of $\frac{1}{40}$ of an inch on each surface at each filling, we have an average of a $\frac{1}{4}$ of an inch of live earth to deal with it. We have an air supply on the top of the water trapped under the slates. It is not a departure or a modification, but only a development of the views previously held. It is an economy of space which has been effected in the slate bed. I repudiate the idea that Mr. Dibdin has modified his views as to aerobic or anaerobic action, or has recanted from the idea that aerobic biological action is the only process which can destroy sewage inoffensively.

MR. E. J. SILCOCK: This paper apparently is principally directed towards the discussion of the part which bacteria play in the re-solution of sewage, and that subject from the scientific point of view is no doubt an exceedingly interesting one, and one to which we should be glad to pay attention at all times, but I venture to think that the paper in the form in which it is presented to us is more suitable for discussion by chemists and bacteriologists than by engineers. It is not the function of the engineer to attempt to demonstrate whether the action is bacterial or chemical, but to obtain that information as far as possible from those gentlemen who are directing their attention to the strictly scientific side of the question. What we want, having heard their views, is to endeavour to design an apparatus which will foster and carry out sewage purification in the best possible way. What we really want to have put

before us, in a paper such as this, is some information as to the degree of purification obtained by this particular form of tank. If the paper had done that it would have shown us the amount of solids in suspension in the crude sewage, and in the effluent from the tank. Then we should have been able to determine whether the tank was doing the work in a more rapid and economical way than other forms of tanks. The separation of the solids in this form of tank appears to be exceedingly good. Personally I came here to see the tank and the results obtained. We want something of a more practical character. The paper does not deal with the question of the further purification of the sewage after the liquid has passed through the tanks. I understood from the first information supplied by Dr. Travis, that the tank was to be followed by an oxidising process in which fans were to be used. That is a complicated system which could not be applied in small installations. It might do for the large Corporations with a big purse, but it seems to me that no such system could be successful in the smaller towns.

The vote of thanks was unanimously accorded.

Mr. Chambers in reply: My objects in writing the paper, were to review and to criticise the more generally accepted theories of sewage purification, and to endeavour to substitute therefor a doctrine which had resulted from four years' continuous research work at the Hampton laboratory. I did not anticipate other than that the views expressed would meet with some measure of hostility, and that they would not be acceptable to some who might take part in the discussion. I have been somewhat agreeably surprised at the paucity of the opposition, and cannot but regard it as evidence that the views of sewage purification are rapidly changing in the direction indicated in the paper. In reply to Mr. Silcock I may say that I thought I should be discharging my obligations to the Association more completely by bringing forward new facts relating to the subject generally, rather than by limiting myself to the operations of the hydrolytic tank, more especially, as the tank itself, and the model hydrolytic tank, will thoroughly be gone into at the sewage works, and the amount of purification effected thereby will be fully explained. I am glad that I shall have an opportunity of replying in writing to the criticisms which have been raised in the discussion, and to any which may be communicated.

COMMUNICATED REPLY.

Mr. Sidney H. Chambers, in reply to the discussion: I cannot agree with the statements made by some of the speakers that the paper is more theoretical than practical, and that it is one which should have been presented to chemists rather than to engineers. I venture to assert that a right interpretation of sewage purification phenomena—a knowledge of the actual changes the sewage undergoes in its transit through the treatment area—is as inherently of the essence of practice, as its elucidation is of the utmost possible interest to the municipal engineer. There is, however, no disputing the fact that, in the paper, I have gone over the very latest theories in respect to sewage disposal, as I have also thought it to be necessary to incorporate views which can now only be looked upon as ancient history. The doctrine upheld in the paper has emanated from Hampton and has resulted from the Hampton researches. No one who has listened to the discussion can seriously contend that that doctrine has in any way suffered thereby. Indeed, with the single exception of Dr. Rideal, it is not controverted, and Dr. Rideal's criticism is markedly less hostile than on previous occasions. Moreover, Dr. Rideal, in his policy of opposition, has signally failed to do himself justice. This is especially evident in his references to the colloidal theory, and to the amount of suspended matter issuing from filters. With regard to the former, Dr. Rideal stated that "this colloidal theory was far beyond the microscope—it required the ultra-microscope to investigate it. As the ultra-microscope is not yet in being we cannot follow this change of the colloidal matter into a solid state." This statement is scarcely courteous to the Author of the paper, who asserted that colloidal particles could be recognised by the ultra-microscope. The principle of the ultra-microscope was enunciated by Siedentopf and Ziegsmondy, and had been carried into effect in 1902. The ultra-microscope has since been in daily use in chemical laboratories all over the world; it has been demonstrated before the Royal Society; and it has also been used by the Author, and those engaged upon the Hampton investigations. The ultra-microscope is not required, as Dr. Rideal stated, to follow the change of the colloidal matter into a solid state. This change, as described in

the paper, can be witnessed by the ordinary observer, and its minuter details seen by the aid of the microscope. It can also be brought about in a moment by the addition of electrolytes, and it can be delayed for weeks. The real object of the ultra-microscope is to render visible particles which lie far beyond the range of the ordinary microscope. By the use of the ultra-microscope the particulate nature of all colloidal solutions has been demonstrated, and the dimensions of the smaller of the particles which can be seen lie in the neighbourhood of the largest molecules. Indeed it has been claimed that the larger molecules of albumen and of certain fluorescent substances have been actually seen. Dr. Rideal's other criticism with regard to the experimental filter is equally unfortunate. His contentions that "the increase of sludge was novel," that "he did not know any other place where that had been established," and that it "was not a filter he should recommend" shows a lack of acquaintance with the literature of the subject as well as with the practical working of filters. The fact that more suspended solids issued from a filter composed of large-sized filter particles than entered it is not novel. It has been illustrated and directly referred to by Colonel Jones and Dr. Travis in their reply to the discussion on their paper before the Institution of Civil Engineers as a "method of eliminating solid matter which ought to be encouraged as it is one of the means of prolonging the practical usefulness of the beds." It has been shown to take place in some of the Massachusetts experimental filters as long ago as 1902. It has also been described by Mr. Watson as occurring in the Birmingham filters, and it has been established in other places. Indeed it may be accepted as a fact that whenever such a filter is not evacuating more suspended matter than is entering it, then that filter is becoming an area of retention, and is on the way to becoming blocked. Mr. R. Aglio Dibdin's denial that Mr. W. J. Dibdin has in any way recanted his formerly expressed opinions can only be regarded as the subject of regret. It in no way modifies the facts as recorded in the paper. It follows, however, that Mr. W. J. Dibdin still maintains that the whole of the organic matters suspended and soluble which are arrested by filters are oxidised by bacteria; and yet Mr. R. Aglio Dibdin himself states that "the bacteria only play the lowest and least part in the destruction of this matter."

The Author cannot conclude his reply without expressing his indebtedness to all those who have taken part in the discussion, and without recording his appreciation of the opportunity afforded him by the Council of the Association for bringing forward his paper, and for their visit to Hampton.

The Members then visited Hampton Court Palace, going over a portion of the historic building.

The party had luncheon together, under the presidency of Mr. J. A. Brodie, at Cleggs Hotel.

In the afternoon visits were made to the National Physical Laboratory, the whole of the buildings, laboratories and testing rooms being open for inspection under the conductorship of Dr. Glazebrook and members of his staff.

At the conclusion of the inspection the President proposed a vote of thanks to Dr. Glazebrook.

The vote of thanks was passed by acclamation.

The Members then proceeded to the sewage disposal works, where they inspected the hydrolitic tank described by Mr. Chambers in his paper.

METROPOLITAN DISTRICT MEETING.

February 28, 1908.

Held at Westminster.

W. NISBET BLAIR, M.INST.C.E., VICE-PRESIDENT, *in the Chair.*

THE CHAIRMAN: Mr. Aldwinckle is not a stranger to our Association. He gave us a paper here, I think in this same building, a few years ago on fire-proof construction and the defence of buildings against fire. Many of us know Mr. Aldwinckle as distinctly in a foremost position to speak on the construction of public baths. I have a special knowledge of the fact, as Mr. Aldwinckle constructed for the Council of St. Pancras a very fine block of baths, which are illustrated on the drawings now before us.

Mr. Aldwinckle then read the following paper:—

PUBLIC BATHS AND WASHHOUSES.

BY T. W. ALDWINCKLE, F.R.I.B.A.

THE importance and value of public baths in relation to the health of the community are now so generally recognised, and the necessity for the provision of such institutions is so generally accepted, that such buildings are now to be found in most of the important towns in the kingdom, sometimes, but not always, of a size and character adequately to fulfil the requirements of the neighbourhood. All public authorities now fully recognise the necessity for these institutions, but as public baths are not usually self-supporting, the fear of putting fresh burdens upon

the ratepayer will often check, and even indefinitely postpone, the development of such schemes. It is thus the imperative duty of the architect when designing public baths to always keep before his mind two important economies, viz. economy in the erection and finish of the buildings, and economy in their administration, the latter being the legitimate result of a well-considered and well-arranged plan.

To begin at the beginning, with the site; the general mistake is made of having this of too small an area for its intended purpose. Baths are most needed in crowded localities where land is expensive, and too little, therefore, is acquired. This necessarily cripples any plan, however well considered, with the result that the several buildings are crowded together with insufficient air space and limited means of intercommunication, and the future administration suffers. Another result frequently is that the new buildings come up too close to those of adjoining owners, resulting in claims in respect of vibration and in respect of interference with light and air. The ideal site is one which admits of all the departments, swimming baths, slipper baths, public laundry, etc., being placed on the ground floor, thus ensuring top lighting and good ventilation. It is also desirable that at least two sides of the site should abut upon a public thoroughfare.

The following points should, the Author thinks, be carefully observed in designing public baths:—

Due separation of sexes and classes.
Efficient supervision.
Economical administration.
Good lighting and ventilation of all parts.
Means of intercommunication throughout.

When public baths are intended for a large town, there will generally be three swimming baths, two for men and one for women. It is unnecessary to have two of these baths for women, as the use of them by this sex is not so general as to warrant such a course. The two classes of women bathers use the bath on alternate days, or some similar arrangement is adopted. In many establishments there is no swimming bath specially dedicated to women, the men's bath being given over to them on certain hours or on certain days. This, however, is to be deprecated. Unless the men's baths are open for men

during the whole of the week, the popularity of the baths will most certainly suffer.

In arranging the buildings upon the site, the swimming baths, being large, have to be considered first, the slipper baths coming in for the smaller areas. But the slipper baths are of equal importance with the swimming baths, and their arrangements must be as carefully considered. This is particularly the case with a site of irregular shape. When a site is large enough, it is far preferable, and for administrative purposes more economical, to have all the slipper baths on the ground floor. Where this is not possible it is better to have these all on the first floor rather than they should be divided over two floors. A good deal of attendance and supervision are required for slipper baths.

There should be separate entrances for the two sexes, if possible in different streets. For men there should be separate entrances for the two classes, one on each side of a central ticket office. So far as men are concerned, the Author thinks that it is most desirable that those who pay for a first-class swim or slipper bath should be free from the rowdyism which sometimes occurs among the second-class bathers. The entrances in all cases (for either sex) should lead as directly and as shortly as possible to the swimming baths, in connection with each of which there should be a good-sized and well-lighted lobby, but not a waiting-room. All long corridors should be carefully avoided. The main entrance should also lead, as directly as possible, to the slipper baths. If these are on the first floor the stairs leading up to same (separate for each sex and class) should be close to the entrances. There should be a well-lighted and ventilated waiting-room adjoining each set of slipper baths.

In designing the swimming baths it must be kept in mind that water is expensive, and that it has to be warmed, which is also costly. Therefore, the swimming ponds should not be unnecessarily large or deep. A good size for the men's bath is 100′ long by 35′ wide, the depth of water ranging from 3′ 6″ to 6′ or 6′ 6″; greater width and greater depth suggests undue consumption of water. The second-class bath should be at least quite as long as the first-class bath. The deepest point should be about 10′ from the end. A good size for the ladies' swimming bath is 75′ by 25′, with a depth of water from 3′ to 6′.

The general design and arrangement of the men's first-class swimming bath will depend upon the question whether this will be used during the winter as a public hall for concerts and entertainments. In many localities a good public hall is much needed, and where that is the case the hall will generally become a source of profit during the winter months. In order that this swimming bath shall be made suitable for such purposes special arrangements must be made as regards entrances and exits, staircases and galleries, and the whole of the hall and its adjuncts would, in London, come under the theatre requirements of the London County Council, and these requirements, while strictly necessary, are calculated greatly to increase the cost. One great difficulty in this matter is that the features which constitute a good hall for swimming-bath purposes do not altogether make a good concert hall. The ventilating lantern and skylight which form an admirable arrangement for a swimming bath, make a very poor ceiling for a concert hall, and have anything but good acoustic qualities.

At the St. Pancras Baths, Kentish Town, an effort was made to cope with this difficulty. The Author did away altogether with the Lantern skylight, and provided a curved inner ceiling of trefoil section, putting a non-ventilating skylight on each side of the roof with steel sashes in the curve of the ceiling, with slightly obscured glass immediately under the skylight. This gives ample light in the Hall for all purposes, and the curved ceiling has good acoustic qualities. This Hall, both in summer and winter, is ventilated on the plenum system, 900,000 cubic feet per hour being driven in at the floor level, the outlets for the vitiated air being in the apex of the ceiling leading into a main outlet trunk communicating directly with the external air. The incoming air is of course warmed not only during the winter but frequently during the bathing season in the so-called summer months. In addition to the main plenum, there is a supplementary plenum system, quite independent of the other, which discharges warmed air halfway up the curve of the ceiling. The object of this is to keep the ceiling, and especially the steel portion of it, warm, and thus to prevent that condensation of the watery vapour which is usually so troublesome in a swimming bath. In this connection it may be mentioned that it is desirable to have all plenum

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ducts and inlets of large area so that the velocity of the air may be low, thus avoiding perceptible draughts of air.

Dealing again with the ordinary details of a swimming bath, the gangways and dressing-boxes should be kept as small as possible, consistent with efficiency, or the size of the building will be unduly increased. For a First Class Men's Bath the gangways should be 4 feet wide at the sides of the pond, 6 feet wide at the shallow end, and at least 8 feet wide at the deep end. The dressing-boxes should be 3′ 6″ by 3′ 6″, the partitions and doors being in teak, the partitions standing 2½″ clear of the floor on gun-metal shoes, and being 6′ 9″ high. For the Women's Swimming Bath, the end gangways may be narrower, but the dressing-boxes can with advantage be a little larger, and 7′ 6″ high, the doors being 5′ 6″ high, the space above being enclosed by a short curtain. It is not desirable to put dressing-boxes at either end of the men's or women's first-class swimming baths. It will generally be found that a sufficient number can be provided at the sides, but this remark does not apply to the second-class swimming baths.

If the Men's Bath is to be used as a Concert Hall in the winter, these boxes should be made removable, which is a very simple matter. These boxes are usually placed under the gallery, if there is one, but they are now sometimes placed on the upper tier of amphitheatre seats rising from the bath gangway. This amphitheatre arrangement has the excellent result that a good view can be obtained of all parts of the pond during swimming competitions and entertainments, which is far from the case with the ordinary gallery, and is far preferable to placing the boxes under or at the back of the amphitheatre seats. Admirable as the amphitheatre arrangement is, and of that there can be no question, it is open to the objection that it considerably increases the width and length of the hall containing the Swimming Pond; the dressing-boxes are not so accessible as in the usual place; and the general arrangement does not lend itself to the purposes of a hall for concerts or entertainments. At the same time, the Author is not at all sure that it is good policy to impair the efficiency of the Swimming Bath for the sake of the winter concerts. Assuming that a gallery will be required, it should run round the two sides and one end, the latter over the shallow end of the pond. It is preferable to have no gallery at the other end, as a gallery interferes with the

arrangements for diving, etc. The gallery must necessarily be steep and shallow, and will not as a rule take more than two rows of seats at the sides, but more rows can be put at the end. It is a very good arrangement, and one that is much appreciated, to put a gallery at one end of the Women's Swimming Bath. All the seats in the gallery must be of the "tip-up" type.

Another arrangement has been carried out at the Camberwell Baths, Old Kent Road, by which the front of the gallery has been set back in a line with the front of the dressing-boxes, the rear part of the gallery standing over a corridor on the floor below. This enables a much better view to be obtained of the bath pond, and retains the dressing-boxes in their usual position, and also admits of an extra row of seats in the gallery.

There should be easy access to the gallery from the ground floor of the Swimming Bath, and also external access, which will be required on the occasions of swimming entertainments.

For the Men's Second Class Swimming Bath, the dressing-boxes must be more numerous and smaller in size. The divisions can be of plain slate, 6′ 6″ high (again kept clear of floor). These boxes can be 2′ 9″ by 2′ 9″, and there can be a fair proportion of boxes a little larger to hold two bathers. As the placing of these boxes along the sides and ends of the bath will not give a sufficient number of them, additional boxes should be arranged in well-lighted transepts or annexes, but not out of proper view and control. The doors should stand about 15″ off the floor, and be 2′ 6″ high.

Great care must be taken with the construction of the bath pond to ensure its being water-tight. The bottom of the pond should have a good thickness of cement concrete, and the walls should be built of brickwork in cement, in preference to concrete, on good foundations. The pond should have a water-tight internal coating of either asphalte or cement, and this should be carefully tested with water before the final linings are fixed. The sides should be lined with white glazed bricks, but for the bottom of the pond Terrazzo paving is preferable, as the straight lines of the brick paving assume horrible contortions when seen through the water. The only objection to Terrazzo is that the water does not look quite so bright as with white glazed bricks. The nosing to the pond should be white marble for first class, and plain slate for second class. A glazed fire-clay scum trough

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should be made up in panels about 7′ by 3′ 6″, tongued and ledged, and with framed ends, rebated diagonally at the corners, and each corner secured with a piece of ¾″ teak, 4″ square, fixed with brass caps and screws to the bearers below; the bearers or joists carrying this floor should run transversely across the pond and rest on strong framed and braced trestles running longitudinally down the pond, and secured to each other with bolts and nuts. This makes a floor which is a good one to dance on, and is of good appearance.

If a swimming bath is designed to be used as a concert hall in the winter, there must be a large public entrance quite separate from the ordinary bathers' entrance, with separate entrances, staircases, and exits to and from the gallery, and there should be ample accommodation for both sexes in the matter of cloak-rooms and lavatories.

It is most desirable that the support of the different swimming clubs should be obtained, and, with a view to this end, it is desirable to provide at least two good club rooms in connection with the men's first-class bath, fitted up with lockers, etc. These rooms should be so arranged as to be suitable for artistes' rooms on the occasions of concerts and other entertainments.

The provision of slipper baths is a costly item in public baths, both as regards the capital outlay and the annual expenditure, and it has been suggested that these baths should be dispensed with and sprays substituted. This would save the cost of fire-clay baths, and also the cost of a good deal of water, as the consumption of water per bather would be much less. The Author is, however, inclined to favour the use of both bath and spray, as he has great doubts whether the spray alone is sufficient for cleansing purposes. The supply of hot and cold water to the bath should be under the control of the attendant, while the bather could control the spray, provision being made to prevent the possibility of scalding. It is not suggested that the spray should be only of cold water. The baths and valves, etc., should be the same for both classes of bathers, but the partitions and appointments will vary. For the first class enamelled slate is a good material for the partitions, marble being still better. Marble, however, is expensive. For the second class, plain slate is suitable. All these partitions should stand 2½″ clear of the floor, and stand on gun-metal or galvanised

iron shoes, and be fixed together with similar cramps. All this work should be very carefully done. The doors should be of wood, preferably teak. The Author has used slate, but they are too heavy, and frequently come to grief. The bath-rooms should be 6′ by 6′ at least, and the partitions 6′ 6″ high. The baths should in all cases be fire-clay glazed inside and over the roll, and should stand on glazed fire-clay feet. As the glazed roll affords no grip for the hands, it is as well to provide a teak handrail about 3′ long fixed to the wall at the side of the bath, so that the bathers can raise themselves after immersion. There should be a small office for the attendant in each class, and the whole of the arrangements should be in the direction of easy supervision and prompt attendance upon the bathers.

Every dressing-box and slipper bath-room should have a teak seat, kept two inches clear of the wall and secured to galvanised iron brackets by gun-metal bolts so as to be easily removable for cleansing purposes; also a looking-glass and hat-pegs.

In some cases, where the space is limited, some of the slipper baths have been placed over a portion of the swimming bath. In fact, this had to be done to a small extent at St. Pancras. Such an arrangement, however, is not desirable, as there should be a good top light over the whole length of the bath pond.

In connection with the swimming and slipper baths it is important there should be means for the immediate disposal of dirty towels, so that these are not lying about the gangways and passages. There should be at least two towel shoots in each department, and these should discharge direct into the basement, and be at once conveyed to the establishment laundry. This may be a convenient opportunity to point out that the subways and passages in the basement should be wide, high, and well lighted, so that all *dirty work* can be done down there instead of on the bath floor. The basement also will be useful for the storage of dressing-boxes from the men's first-class swim during the winter, and of the temporary floor and staging during the summer, as also the chairs from the public hall, and also as a general means of intercommunication between the several departments.

The public washhouse will have its own separate entrance,

but this may, if possible, adjoin the pay office of the women's entrance, the same office being worked for both. It will be necessary to provide a barrier or turnstile just past the pay office. The number of washing compartments will depend upon the needs of the neighbourhood, but fifty is an average number. Each compartment contains three divisions for washing, boiling, and rinsing, all being of iron enamelled internally. The wringers or hydro extractor should be under-driven by hydraulic power, and should have safety interlocking covers. There will be a drying chamber with a number of pull-out horses equal to the number of washing compartments, each horse numbered to correspond with the number of the washing compartment. It is preferable to heat and ventilate this drying chamber on the plenum system, supplemented by steam coils placed in the chamber. The horses should have the back plates so arranged that when fully drawn out this plate will close the opening, otherwise the plenum fan will be driving hot air into the washhouse. There will also be a mangling room. At the entrance there should be a good waiting-room, a cloak-room with lock-up lockers, and, if possible, a *crèche*. The ventilation of the washhouse requires careful attention, as there is a large amount of steam being produced in the room when fifty washing compartments are in full work. A large fan is absolutely necessary in order to quickly remove this steam, but in order to render this fan really effective, provision must be made for the admission, at suitable points, of plenty of external air. The floor of the washhouse, which should be of Terrazzo, should be laid to good falls, so that water will drain away easily. The general arrangements of the public washhouse should always admit of good supervision.

The establishment laundry is required for the washing of towels, bath costumes, etc. It is most important that this department should be arranged on a scale suitable to cope with the large amount of business which accrues in hot weather. There will be required a washing machine, a wringer, a boiling copper, washing tubs, a steam ironer, and a rinser, those requiring motive power being driven from an electric motor, and about fifteen drying horses, which should be heated and ventilated as described for the public washhouse. In connection with this laundry lifts should be provided in suitable positions to send up the clean towels to each department.

The warming and ventilation of a large public bathing establishment are of great importance and present some difficulties. Where the first-class bath is to be used as a public hall, the warming and ventilation should be on the plenum system, as already described. But for the other departments other means will be necessary. As regards warming, it must be remembered that even in the bathing season our climate presents us with a good deal of cold weather, and that means must be provided for maintaining a good temperature even in departments which are opened only for the so-called summer season. As the temperature of the water in the swimming baths is generally 73° and often 75°, the bath buildings must have a fair temperature, or bathers might take a chill after leaving the water. All this applies with even stronger force to the slipper baths, which are open during the whole year. The best system of warming is by means of radiators on a hot-water low-pressure circulating system, circulating from steam heaters in the basement. In order to prevent condensation in the open lantern roof, which is a source of great annoyance, it is a good plan to run a hot-water circulating pipe round the lower part of the roof lantern.

As regards ventilation, apart from plenty of open windows, all departments should have, where possible, open roofs with ventilating lantern skylights, each with a good electrically-driven fan. These fans must be large and powerful, as small fans are perfectly useless in removing steam and vapour. But in all cases where these fans are used, proper inlets for external air must be provided, and these should be somewhat near the floor level, so as to obtain a through current of air. No fan will be efficient without this provision.

The supply of hot water for the establishment must be arranged on a liberal scale, so as to meet special demands in the hot weather. The hot water should circulate by gravity from steam heaters in the basement, and it is most important that these heaters should be of a suitable size, and with sufficient heating surface to supply the required amount of hot water for the slipper baths at the busiest season. The quantity of hot water required should be accurately ascertained, after which the provision of the requisite amount of heating surface can easily be calculated. This is not always done, with the result that the hot water supply fails at the critical

moment. The circulating pipes can, as a rule, be slung under the floor of the slipper baths.

The arrangements for the cold water supply for a large bathing establishment have to be on a large scale. A swimming bath 100′ by 35′ takes upwards of 100,000 gallons of water, and as the bath has to be emptied, cleansed, and refilled between 10 p.m. and 6 a.m., the mains must be large. If the water company's water is to be used, and there is a good pressure, there need be no difficulty, but the size of the main must be carefully considered. In this connection it must also be pointed out that the emptying pipes must be large in order that the bath may be emptied in a short time, not forgetting that the head of water for the emptying process is very slight, being from 6 feet down to nil. The bath having been refilled with water at perhaps 50°, this water has to be warmed up to say 73°. This is best done by means of circulating pipes, with a steam ejector drawing in the cold water and then ejecting the same into the pond at a higher temperature. When once the required temperature is reached in this large bulk of water it takes a very little steam to maintain it.

In the event, however, of an artesian well being sunk, there is another method of warming available, which is employed at the St. Pancras Baths. There two borings were sunk and provide a yield of about 26,000 gallons per hour. Instead of pumps, the "Air Lift" process was used, by which compressed air at a high pressure drives the water up an inner tube placed down the bore pipe. Thus there are no pumps at a great depth to get out of order, the whole of the gearing is on the surface. The air compressor is driven by steam, and the exhaust steam from the same passes through a condenser. The whole of the water raised from the well passes through this condenser, and its temperature is raised by the exhaust steam to 73° or 74°, at which it enters the swimming ponds, and thus warms the whole of this water without any further expenditure of fuel than is required to drive the air compressor. This is by far the most economical arrangement known to the Author. The circulating pipes already referred to should not, however, be dispensed with, as pumping machinery occasionally breaks down.

The provision of ample cold-water storage is essential, but mainly for the supply of the slipper baths, laundries, and boilers,

the swimming baths being dependent upon the Company's direct supply, or from a well. It must be obvious that unless a large area of additional land were acquired there can be no storage capable of filling even one swimming bath. It will generally be found that a storage. capacity of 20,000 gallons will be sufficient for the purposes named.

Owing to the exigencies of space, the boiler house, which is a most important department, is frequently placed under the public washhouse, or some other department, resulting in unsatisfactory conditions of lighting and ventilation. Wherever possible the boiler house should have an open roof and lantern skylight. When this is done there will usually be ample height for multitubular boilers, which are more economical in working than Lancashire boilers. But whatever type of boiler is used, it is most desirable that before deciding upon their size, careful calculations should be made of the duty to be done, the amount of hot water required for the slipper baths and laundries, tho units of heat required for the heating apparatus, and the amount of steam required for motive power. Boilers of a capacity unequal to the duty required are always a source of considerable trouble. The boiler house should be as centrally placed as possible.

There should be in the basement a large amount of storage accommodation, for general stores, towels, engineer's stores, etc., and a large and well-lighted engineer's shop; the latter is always a busy place in a large establishment.

A residence has to be provided for the superintendent. This should comprise two parlours, three bedrooms, kitchen, scullery, bath-room, stores, etc. All this accommodation can generally be arranged on one of the upper floors. The engineer also requires a residence, which should comprise parlour, two bedrooms, kitchen, and store. This residence must not be entered from the baths establishment. The superintendent's office should be easily accessible and preferably near the entrance.

There should be provided, by means of doors, etc., intercommunication between the several departments, so that the superintendent and his wife can get access to all parts conveniently and without loss of time.

In some baths, refreshment rooms are provided. Where this is the case, they should be near the entrances, so as to be

under proper control. The separation of first and second classes should be maintained in these rooms.

Each department should be well supplied with sanitary conveniences, in well-lighted and ventilated annexes, separated from the bath halls, etc., by a cross-ventilated lobby.

One word as to the engineering work at public baths. This work is by far the most important of any department in an institution of this kind, and it is of the highest importance that the details should not only have been carefully considered, but that the work itself should be of the highest class. A break-down in this department paralyses the whole of the work of the bath. Whatever economies may be practised, it is the best and cheapest policy to pay a good price for this work, and to entrust its execution to none but high-class engineering firms.

The internal finishings of public baths should be designed primarily with a view to cleanliness. The walls of the swimming baths and slipper baths should be lined throughout with white glazed bricks, as this is the only material which can easily be kept clean. For corridors, passages and gangways, except to the basement, the best paving is Terrazzo paving, as it is bright and cheerful, and easily cleaned. All internal paintwork should be kept as light as possible, not only for the sake of brightness, so essential in a bath, but also in the interests of cleanliness.

The external architectural features of the buildings should, in my opinion, be simple and dignified, suggestive of the intended purpose of the building. Any elaboration of the elevations is a waste of public money, having regard to the fact that the cost of these buildings is defrayed, not from voluntary subscriptions, but from money raised by rates from the pockets of the ratepayers.

DISCUSSION.

MR. H. PERCY BOULNOIS, Local Government Board: I have pleasure in moving a vote of thanks to the Author. With regard to the length of the swimming-bath—100 feet—I take it that that is the right length for swimming matches. I understand that straight lines on the floor of the bath are necessary to guide divers when doing scientific diving. In the provinces,

and particularly in the manufacturing towns—I do not know whether it is so in London—the bathers have to go through what is called a dirty bath to wash off the filth from their bodies before going into the swimming-bath. I should like to know whether Mr. Aldwinckle considers that description of bath should be simply a trough with hot water and soap, or something in the nature of a douche? As to making a bath watertight, I wish to know whether Mr. Aldwinckle has found Callender's bituminous sheeting equally as effective as asphalt, or whether it is not sufficiently tough, or strong, or lasting to answer the purpose. Also, whether he has any experience of ferro-concrete for a swimming-bath. The difficulty with ferro-concrete is that it is exceedingly light, and, if there is any outside water, it is practically a tank, and likely to float. With regard to the roofs of swimming-baths, I must say that many architects seem incapable of making a design for a strong bath roof combined with sufficient lightness. I would like to suggest the use in the roof of fortified glass, because, with breakage of ordinary glass, very serious accidents might happen. As to heating the bath, the steam-jet is the better way, and not the old circulating system. In designs of baths there are frequently not sufficient conveniences put in, that is urinals and water-closets. I do not know whether there is any defined proportion of conveniences which ought to be put in, but they very often fall short of requirements. With regard to the slipper-bath, I do not think it will ever go out of popularity. Many people like the luxury of lying in a warm bath; they do not care for the spray bath. Then, with regard to boilers, Mr. Aldwinckle is perfectly right. I often get designs in which boilers are placed in such a position that they must be built in; you cannot get them out without pulling down a wall. They forget that the boiler has to come out and another has to go in again. I find that cast-iron pipes fail, owing to the damp atmosphere, and that copper pipes, although exceedingly expensive at the outset, are the cheapest to use. As to the number of first- and second-class slipper-baths, very few architects seem to be aware that this is regulated by an Act of Parliament passed in 1846: "If more than one class, the number of second-class slipper-baths must be at least double the number of first-class, and if more than two classes the number of the lower class must be double the number of the higher classes added

together." I have pleasure in moving a vote of thanks to Mr. Aldwinckle for an exceedingly practical paper.

Dr. R. K. Brown, Medical Officer of Health, Bermondsey: I have pleasure in seconding the vote of thanks. Mr. Boulnois has called attention to the proposed length of the swimming-bath. The length which Mr. Aldwinckle thinks the best is 100 feet; I think that is hardly long enough. A bath is designed primarily for swimming purposes. I would rather have a bath 50 yards long, or say 44 yards. It should be a fraction of a mile. If it takes too much water, it will be better to have a reduction in the depth. Beyond a depth of 5 feet 6 inches it is not much good for swimming purposes. The Camberwell baths are about 25 yards long. But those baths are very little used for athletic purposes; they are principally used for socials and dances during the winter. I have been in those baths, and I think the depth there must run to 7 feet 6 inches. I do not see the slightest advantage in that depth of water, except for high diving, and I think this is not a thing to be encouraged among school children, as there is a danger to the drums of the ears and of strain on the heart. For adults it does not do any harm, but the practice of these things by children is not to be commended. As to the ventilation of baths, I think the plenum system a very good one. The baths very often have to be used at night, when it is impossible to get natural ventilation without chilling the bathers.

Mr. R. J. Angel: It is far better to place the dressing-boxes at the side of the bath. I do not agree with the tucking of them away under the amphitheatre seats. In those baths where the dressing-boxes are under the gallery there is a great difficulty in lighting. No light gets direct to the boxes. Reference has also been made to the heating of the water. I do not wish to say very much about that, as I refer to it in my paper, but in the system which is referred to there the water is kept at the same heat throughout the day—that is by circulation. Another important thing is the provision of a foot-bath. Some degree of authority should be given to the attendant as to compelling the use of the foot-bath. He should have power to prevent a person going into the swimming-bath before using the foot-bath, if necessary. A good deal of the impurity which gets into the water might be avoided in that way.

Mr. J. Rush Dixon: I should like to add my congratulations

to Mr. Aldwinckle for what, after a careful reading, appears to be a paper teeming with information to any one interested in this question of baths. As to the dressing-boxes, I question very much whether it is economical to have removable dressing-boxes, especially considering the wear and tear of removal. I agree that the idea of boxes being placed under the gallery which extends down to the floor, as at the Haggerston Baths, Shoreditch, is a mistake. It is a most inconvenient box for the bather, and a great nuisance to the people on the gallery. The question of the gallery projection is one of the difficulties all of us have to face. If the gallery projects very far into the hall, it has to be carried on stanchions, and, if the hall has to be used for public purposes, such as dancing and the like, the stanchions are a nuisance. With reinforced concrete a good deal of the difficulty has been overcome, and if the gallery is carried out as at Hammersmith Baths, no stanchions are needed. But in ordinary cases there is not sufficient side room to allow of the whole gallery being supported by cantilevers. As to the paving round the swimming-ponds, no mention is made of the slippery and dangerous condition into which granolithic usually gets when wet, and terrazzo paving is also apt to become slippery. I find the use of Ruabon ribbed tiles not only prevents that slipperiness, but adds somewhat to the attractiveness of the bath. They are a nice rich red, look warm, and help the decoration. Then, to assist in keeping the water clean, a long foot-trough or channel about a foot deep, with a stream of water constantly running through, is a great help. With regard to the slipper-bath divisions, slate so soon becomes scratched and disfigured that, although a little more has to be paid for marble—say, St. Anne's, or something of that description—it really proves more economical in the end. The question of keeping the divisions clear of the floor is somewhat of an open one, because, unless care is taken, there is likely to be a draught underneath. With regard to the slipper-baths themselves, I think Mr. Aldwinckle recommends that they should have feet on the four corners to raise them above the floor. I think that is a mistake, as there should be no space under the bath where dirt can accumulate and not be easily removed. I have come to the conclusion that the best method is to make up any space underneath with a concrete seating properly rounded off from the floor. I have also found it most useful to have all

kinds of spare places in the nature of bicycle-stores and the like, and you can hardly have too many conveniences, especially if the swimming-baths are going to be used for public entertainments. Mr. Aldwinckle recommends that there should be a drying-horse for towels in the establishment laundry. I think the better method is to have a roller ironer there, with a steam bed, into which the towels can be put to both dry and iron in one operation. I congratulate the Association upon having before it a paper of this valuable kind, and support the vote of thanks to Mr. Aldwinckle.

MR. O. E. WINTER: I only want to make one remark which has occurred to me, arising from my own experience with the swimming-baths at Hampstead. There was some difficulty for years with leakage from the swimming-baths, and which gradually became so pronounced that some steps had to be taken to stop it. The difficulty was greater as, owing to the levels of the site, the higher bath is twenty feet above the level of the lower bath. We had ultimately to cut away the whole of the glazed brick lining of the sides and floors of the baths, and put in an asphalt course and reline the baths; that has effectually remedied the leakage. Mr. Aldwinckle has suggested the putting in of either an asphalt or cement lining. It seems to me cement is not sufficient to prevent leakage, and that either asphalt or—as suggested by Mr. Boulnois—Callender's bituminous lining is required. We have been trying winter cricket in the baths at Hampstead, but it has not been a financial success. The gymnastic and badminton classes, however, pay very well and are much appreciated.

MR. S. G. GAMBLE: There is one point in connection with this subject that has not been touched upon, and that is letting for entertainments. Is it absolutely necessary from a financial point of view that baths should be so constructed that they can be turned practically into music halls during the winter months? It seems to me they should be planned for one purpose or the other.

MR. F. SUMNER: There is one important point that I was pleased to hear Mr. Boulnois touch upon, that is, as to the proportion of slipper-baths required to be provided by the Act.

In designing baths we find it a very onerous requirement to get the full proportion of second baths to the first required by

the Act, and very frequently the numbers having regard to the district served are not required.

I believe if we could have smaller units of slipper baths in various parts of the district, placing first-class baths where such are required, and second class where these are needed, it would be better than having them altogether in proportion called for by the Act. We want to bring the baths to the people who require them, as the people will not walk any great distance to the baths.

MR. BOULNOIS: I do not follow how the Act would effect it. If you had units you would still require to have the same proportion of first, second, and third-class slipper-baths.

MR. CHAMBERS SMITH: As to securing the watertightness of a bath, Mr. Aldwinckle suggests cement. My opinion is that cement cannot be depended upon for watertightness. In my own district we have concrete floors, and the bath was built upon the solid chalk, and yet, after being built eighteen months, there were serious cracks. The only way of preventing leakage is by putting in Callender's or some other bituminous lining. Mr. Aldwinckle recommends that the doors of the dressing-boxes should be 5 feet 6 inches high. I do not think that is so good as having a door 3 feet 6 inches high, and a curtain of red baize above.

MR. J. S. PICKERING: I should like to ask Mr. Aldwinckle whether he has any objection to a slipper-bath with dressing-boxes on either side. This system is not mentioned in the paper. It is a very economical method of construction, as directly a bather has finished he can go into one dressing-box, and the other is available for the next bather.

THE CHAIRMAN: I am quite sure we are unanimous in according to Mr. Aldwinckle the thanks of the Association for his very interesting paper. You do not get the custom for swimming in the winter that makes it worth while filling and emptying all the baths regularly. You may meet the demand by keeping open one bath, and by putting a floor over you are able to use the others for concerts and meetings, and in St. Pancras the women's bath is used as a gymnasium. It is an advantage to use these large premises in other ways than as baths, which would be idle during the winter season. You get a certain revenue from those other purposes which goes to meet the outgoings. The greatest cost is, of course, the interest on capital.

COMMUNICATED REPLY.

Mr. T. W. Aldwinckle, in reply: First-class swimming baths should be generally made 100 feet long, as three lengths make 100 yards, which is a standard length in swimming contests. In some cases a fraction of a mile has been chosen as a standard of length, such as 44 yards, which is a fortieth of a mile, but this length is too great for any purposes except swimming contests, and would be costly both as regards water supply and warming. I advocate terrazzo paving at the bottom of the bath ponds, as the straight lines of glazed bricks take unsightly shapes as seen through the water. For the purpose of guiding swimmers and divers I arrange in the terrazzo paving dark lines 4 inches wide and about 5 feet apart, running longitudinally. This meets all purposes. I think there is a great future for ferro-concrete in connection with bath construction, and that considerable economy can be effected by its use. The use of fortified glass in the skylights is advisable where the latter are close to the street, but in other positions I do not think it necessary. It is more expensive than ordinary glass; and there is necessarily a large area of it. Copper piping would always be preferable to iron piping, but the additional expense would be enormous in respect of the main pipes, and there would be a large area of bright metal to be kept clean, involving additional labour, which has to be paid for. It was suggested by Dr. Brown that swimming baths should be longer, and that to meet this economy in water might be effected by reducing the depth. This would, however, interfere with diving, which is extremely popular. Moreover, I do not think that the usual depth, which is from 3 feet 6 inches, to 6 feet 6 inches, could well be reduced without interfering with the general usefulness of the bath. I am quite in favour of marble partitions for slipper bath-rooms in preference to enamelled slate, as the latter soon becomes damaged, and to my mind marble is naturally a more cleansible material, but the latter is undoubtedly more expensive, especially in the lighter colours, and a dark marble would be unsuitable as not easily showing up the dirt. It is an excellent arrangement to have no clear spaces between the fireclay bath and the floor. In some recent hospital work I have bedded these baths on 4 inches of cement concrete, bringing up the terrazzo paving as a curved skirting all round.

Care must, however, be taken to leave quite free the waste pipe and trap. I do not like any partitions or divisions in connection with bath rooms or dressing-boxes to be brought down close to the floor. This provides square internal angles which are difficult to clean. When these divisions stand clear of the floor it is easy to wash down the paving of the entire area as a whole, instead of dividing the operation into a number of limited areas. A considerable amount of labour is thus saved. I do not think that terrazzo paving is slippery if kept quite clean. It should be cleansed with water very frequently. I have, however, often used the Ruabon tiles mentioned by Mr. Rush Dixon, which are excellent. Steam roller ironers are very effective for drying purposes, and should be very useful in the establishment laundry. As regards the watertightness of swimming bath ponds, this is a very important matter, as leakages are very difficult to put right afterwards. On the whole I think it is safer to line the pond with asphalte in preference to cement. In any case, the pond should be carefully tested after being lined and before any glazed brick inner walls or terrazzo paving are executed. A reference was made to the height of the doors to the dressing-boxes. In connection with the first class-baths, I think that the doors should be quite 5 feet 6 inches high, as this class of bathers desire privacy. Curtains are only suitable for ladies' baths. But for the second-class swims it is, for several obvious reasons, most desirable that the doors should be so low that the attendant can have a fair view of what is going on inside. These doors should be 12 inches clear of the floor and the top of the door should not exceed 4 feet above the paving. With reference to the suggestion that slipper bath-rooms should have separate dressing-rooms, one on each side of the bath-room, in order to ensure economy of time in the use of the baths, I may say that such an arrangement is already in use in connection with spray baths, but I know of none in connection with slipper baths. It appears to me an excellent idea, as a somewhat smaller number of slipper baths would be required, each bath being used more frequently. I fear, however, that a much larger floor area would be occupied, as a slipper bath-room cannot well be smaller than 6 feet by 5 feet, and there would be in addition two dressing-boxes to each bath. The case is different with spray baths, which do not require a room more than 5 feet by 3 feet

3 inches. It is an admirable suggestion that small groups of slipper baths should be placed among the poorer districts, in order to bring these within an easy distance of the homes of the people. If arranged on a very moderate scale the expenses of administration should not be great. The principal item of the initial cost would be the hot-water supplies. All washing of towels, etc., could be done at the main central establishment.

CONTINUOUS FILTRATION OF BATH WATER: A DESCRIPTION OF ITS WORKING.

By ROBERT J. ANGEL, M.Inst.C.E., A.R.I.B.A.,
Borough Engineer and Surveyor of Bermondsey.

The system of maintaining the purity of water used in swimming-baths by continuous filtration as opposed to repeated renewals is a modern idea, and promises to become generally used, judging by the results obtained in institutions where the system is already installed. The adoption of such a system is based not only on the question of economy, but also on the proved hygienic advantages it possesses. If the cost of water and heating is such that the bath can be filled with repeated renewals at frequent intervals for a small annual charge, it is, of course, obvious that this method must be preferable to continuously filtering the same water. If these renewals cannot take place with sufficient frequency to allow the water to be used with a tolerable degree of cleanliness for the last bather, then the argument must be all in favour of some such system as here described.

There is no doubt that a certain amount of prejudice exists in the minds of some regarding refiltered bath water, but this has been found to be chiefly among those who do not use the bath at all. When bathers have seen and tried the water, or had the working of the plant explained to them, there has been no instance within the Author's knowledge where anything but satisfaction with the water has existed.

The following advantages are claimed for continuous filtration:—(1) The water is never allowed to get into an unclean state, such as may be the experience of the last bather in water ready to be thrown away under the old system. (2) The water is uniformly heated throughout at all times, and those cold areas which exist during the first hour or two in water heated after filling are avoided. (3) A total absence, even in a crowded bath, of that close "body" smell so well known in the atmosphere of most public swimming-baths which are

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much used. (4) A continuous current of water is maintained through the bath. (5) Economy of water. (6) Saving of time of the employees attending in the early hours of the morning to heat up a fresh bath.

A sample of the water was taken from the bath just before emptying on May 22, 1906, before the filtration plant was installed, and it was analysed. The water had been in use three days, and about eight hundred persons had bathed in it (many being school-children). To the eye it presented the usual appearance of bath water. The analysis which is given later on in the paper is intended to show the effect of filtration.

The plant in connection with the system of purification which has come more particularly under the Author's notice was installed at the Rotherhithe Baths, in the Borough of Bermondsey, and commenced working on October 28, 1906, at which date the first-class bath was filled with water, and it remained there until April 8, 1907, during which time 2607 persons used it, and at that date it was analysed. This water was then changed from the first-class to the second-class bath, and the first-class filled with fresh water. (The second-class bath is closed during the winter months.)

It was considered necessary to put the plant to the severest test possible, and so, as the condition and appearance of the water seemed unchanged, the same water which was turned out of the first-class into the second-class bath on April 8, 1907, was allowed to remain there until August 2, 1907—a period of nine months, during which time 30,873 persons used it, when it was again analysed. At that date both baths were emptied and refilled from the mains. It must, of course, be clearly understood that the Author does not advocate such a long period in general practice, but the analysis compares favourably with the untreated bath water before the plant was installed.

The water is intended to be renewed twice during the summer season and once during the winter.

Two foot-baths were provided for bathers to use before entering the water, should occasion require it.

There are a few points gained by experience in working, one being that the filters should be thoroughly cleaned out at periods regulated by the number of bathers using the water, and not left to be done at stated intervals. No ferns or other plants should be allowed in any position where either the earth

or moisture from the soil can drop into the bath, as minute forms of life come from the soil and thrive in the water, and for the same reason the exposed water on the roof in the aerator should be carefully guarded. As much live steam as can be economically obtained should be passed through the filter during cleansing.

STATEMENT SHOWING THE DIFFERENCE IN COST OF WORKING THE BATH BEFORE AND AFTER THE INSTALLATION OF THE PLANT, EXCLUSIVE OF COAL AND LABOUR.

During the year ending October 31, 1906, *i.e.* the twelve months preceding the erection of the plant, the first-class bath was refilled fifty-six times, and the second-class sixty-two times.

	£	s.	d.
Cost of water at 6*d.* per 1000 gallons—			
56 times at 2*l.*; 62 times at 1*l.* 17*s.*	226	14	0
(Prices vary, owing to difference in size of baths.)			
Overtime in cleaning baths	16	6	0
	£243	0	0

For the year ending October 31, 1907, being one complete year's working of the plant, the first-class swimming-bath was filled twice with water from the town's supply, and the second-class once from the town's supply, and once with water taken from the first-class bath, equalling a total cost for water of 5*l.* 17*s.*, and the remaining items are set out as follows:—

	£	s.	d.
Water	5	17	0
Oil for pumps	1	11	6
Overtime for cleaning baths	11	9	2
Cleansing filter 65 times, consumption of water being 413,375 gallons	10	7	0
Estimated cost of—			
A. Evaporation of water from aerator B. Water used for spraying surface of baths C. Water used for foot-baths D. Boiler ...	25	10	0
	£54	14	8

(There appears to have been six times too much water used on the flushing.)
If the cost of plant had been defrayed out of loan, the repayment and interest would have to be added to this.

The cost of the coal used in the building could not be divided between the swimming-baths, slipper-baths, and laundry; but as a matter of fact the total quantity used during the year ending October, 1906, was 474 tons, and that during

the year ending October, 1907, was 486 tons; therefore, as the consumption was so nearly equal, it is neglected from the calculations when comparing each year, as there was no reason to believe that any variations had taken place in any of the other departments of the baths than that under consideration.

The quantity of coal consumed for the pumps, etc., has since been ascertained to be 10 cwts. per day of 15 hrs. to maintain a 40 lbs. pressure of steam.

As there is no additional, nor any saving of, labour in maintaining heat during the day or attention to the pumps under either the old or new systems, the question of employees has been left out of the comparison.

There is practically nothing to get out of order or requiring renewal, so that no depreciation or maintenance of machinery has been considered, the only moving parts being the two small pumps; and the filtering material, being cleansed every few days, will probably not require renewing for years, as it is entirely enclosed in the cast-iron tank.

As matters stand, therefore, at present the scheme shows a saving of 188*l*. 5*s*. 4*d*. on the year's working.

In the purification of the water there are three different processes engaged, viz. (1) mechanical, (2) biological, and (3) chemical; and although the result is the same, viz. the conversion of complex organic compounds into simpler ones, it is difficult to apportion the exact share which each takes in producing the final result.

In the first place, there is the mechanical cleansing of the water from the coarser impurities by the filter. This is self-evident, and needs no explanation. Naturally, the finer the material in the filter, and the thicker the layer through which the water has to pass, the more effectual this will be.

The next process, the biological, also takes place in the filter, and is probably due to the activity of anærobic organisms in its interstices. These organisms assist in splitting up the complex organic matters mentioned through their various stages, viz. ammonia and nitrites, into the end products known as nitrates.

The periodical cleansing of this filter by "live" steam, no doubt, puts a temporary check on this action, but when the water is put through the filter again, the spar will soon regain a fresh supply of anærobes.

The third cleansing process (chemical) is that due to the exposure of the water to the atmosphere by the aerator on the roof. This is principally one of oxidation, in which the greater portion of the organic matter will be destroyed by the combination of the atmospheric oxygen with it, the final products being water, carbonic acid, and an innocuous residue. Saline ammonia and any volatile animal products in the water will also be got rid of during this process of aeration. This, no one who takes the trouble to visit the aerator can doubt, for the sense of smell will convince him that a number of such products are freely given off.

These various end products are represented in the filtered water by chlorides of the alkalies and alkaline earths, as well as nitrates of the same bases, and these in themselves are perfectly harmless. The worst that can take place is their gradual accumulation in the water.

The water has been analysed, both before and since the plant has been installed, chemically by Mr. R. Bodmer, F.I.C., F.C.S., the Borough Analyst, and bacteriologically by Dr. John Eyre, M.D., F.R.S., Edin., the Bacteriologist to Guy's Hospital, and reported on from time to time by Dr. R. K. Brown, B.A., M.D., D.P.H., Lond., the Medical Officer of Health of Bermondsey.

CHEMICAL ANALYSIS.

Sample.	A. May 22, 1906, before plant was erected. Water in use for 3 days, and used by 800 people.	B. April 8, 1907, after plant had worked 5 months, and water been used by 2607 people.	C. July, 29, 1907, after plant had worked for 9 months, and same water in use all that time as previously explained, and used by 30,873 people.
Colour in 2-ft. tube ...	Yellowish green	Pale green and clear	Pale green and clear
Suspended matter ...	Appreciable amount	Practically none	A few vegetable fibres
Odour	None	None	None
		Grains per gallon.	
Total solid residue ...	21·87	31·85	22·40
Loss on ignition	3·67	4·20	2·45
Combined chlorine ...	1·50	1·60	1·66
Equal to sodium chloride	2·47	2·64	2·73
Nitrogen as nitrates ...	0·03	0·30	0·70
Nitrites	Present	Present	None
Saline and free ammonia	0·007	0·0015	0·0065
Albumenoid ammonia ...	0·056	0·0155	0·0160
Oxygen absorbed from permanganate in 4 hours at 80° Fahr.	0·781	0·101	0·088

The analyst's remarks respecting sample A (unfiltered) are that it is a very much polluted water, and contained numerous bacteria—being, in fact, unfit for use, and might possibly be injurious to health if any quantity was accidentally swallowed.

With regard to sample B (filtered), he states that the organic matter equalled only about one-sixth the quantity in A (unfiltered). There was no epithelium or bacilli adhering thereto, as was found in the untreated water. He considered the water very good, and still fit to use, although it had been in the bath five months.

With regard to sample C (in use for nine months), this water contains from one-third to one-ninth the amount of unoxidised organic matter found in the untreated water, but the nitrates show that much of the organic matter has been oxidised, and thus rendered harmless; and, "considering the long period (nine months) during which the water has been in use, the results are certainly very good." (The Author has previously mentioned that this long test was used only to ascertain the capabilities of the plant. The water was continuously and carefully watched by the medical officer during that period.)

Bacteriological Analysis.

Sample of water taken on April 8, 1907 (*in use five months*).

1. Number of living micro-organisms per cubic centimetre capable of multiplying on gelatine at 20° C.,

5000.

2. Number of living micro-organisms per cubic centimetre capable of multiplying on agar at 37° C.,

645.

Ratio of 1 to 2 = 7·7 : 1.

3. Bacilli coli present in 1 cc. of the water sample, but not in *every* 0·1 cc.

4. Streptococci absent from 110 cc. of the water sample.

5. Ordinary skin staphylococci present in 10 cc. of the water sample.

Remarks.—The result of the bacteriological examination of this sample affords satisfactory evidence of the efficiency of the

treatment to which the Rotherhithe Bath water is subjected. As it is obviously impossible to compare it with drinking water, for which it is not intended, it will be sufficient to say that bacteriologically it contains approximately the number and variety of organisms that would be present in a public bath water that has been in ordinary use for a very short time only. In its naked-eye appearance and lack of odour and sediment it resembles the water from a newly filled bath. It may also be noted that none of the specific bacteria of infectious diseases could be detected.

(Signed) JOHN EYRE.

Sample of water taken on July 29, 1907 (*in use* 9 *months*).

1. Number of living micro-organisms per cubic centimetre capable of development upon gelatine at 22° C.,

3183.

2. Number of living micro-organisms per cubic centimetre capable of development upon agar at 37° C.,

448.

Ratio of 1 to 2 = 7·1 : 1.

3. Microbes of indication—

Bacilli coli present in 1 cc. of the water sample, but not in 0·1 cc.
Streptococci absent from 50 cc.

Remarks.—The present sample of water compares well with the previous sample collected from these baths, April 8, 1907. The total number of organisms present per cc. is distinctly smaller. Both those developing at the air temperature and those developing at the body temperature have been reduced, so that the ratio remains practically the same. Bacilli coli communis are present in unaltered numbers, but it is a significant fact that coliform bacilli are present in lower dilutions, viz. in 0·1 cc. All those found in the previous sample were typical coli bacilli.

(Signed) JOHN EYRE, M.D., F.R.S., Edin.,
Bacteriologist to Guy's Hospital, etc.

The following is a description of the working of the scheme:—

The water is first put into the first- and second-class baths direct from the main, and then alternately allowed to gravitate to a strainer, which eliminates such solid particles as portions of bathing costumes, grit, hair-pins, etc., etc. The water is afterwards raised by pumps to the aerating tower, which is fixed on the roof, by which means the whole of the water is broken up and exposed to the atmosphere, and thus it receives a fresh supply of oxygen. The water then descends and passes through the filter, which purifies it. Then it passes through a heater, which is worked by the spent steam from the pumps and from other parts of the building, and a small quantity of live steam producing a temperature of 74°, and after this, the water is delivered into the shallow end of the bath, again fit for bathing. This process is continuous. The filter is cleansed about every second or third day, by passing about 2000 gallons of water and live steam the reverse way through the filtering media, and washing the accumulation out into the sewer. The first- and second-class baths are worked alternately, and the plant will deal with 20,000 gallons per hour; the water in the large swim being changed every 4½ hours by this process of circulation. As the baths are situated near manufacturing works, there is a tendency for dust to blow in through the louvre ventilators during the night, and settle on the water; therefore a spray is used each morning to clean off the top surface, and it also replenishes any water lost by evaporation and that used in the emptying of the filtering chamber during the periods of cleansing. The cost of the plant and builders' work was 965*l*., and was defrayed out of revenue.

The various parts consist of—

1. A strainer to intercept particles likely to obstruct the pumps.

2. Two pumps to deliver the water to the aerator.

3. An aerator to oxygenate the water, situated on the roof.

4. A filter capable of filtering the water, provided with means of cleansing the filtering surface when required.

5. A heater-condenser capable of condensing the steam used by the pump, and of raising the temperature of the water from about 50° to 74° Fahr. when suppled with auxiliary live steam.

6. A break-tank for re-aerating the water.

Strainer.—The strainer consists of a cast-iron shell having two branches, the one connected to the bath, and the other to the pump suction. The shell is provided with a cast-iron cover and a removable perforated cylinder of copper, so arranged as to be easily removable for cleansing when required.

Pumps.—There are two pumps, each being 8½ ins. diameter and 15 ins. stroke, and work 36 double strokes per minute, delivering the 10,000 gallons of water to a height of 40 ft. to the aerator on the roof, the suction being connected to the respective baths. The pumps are of the vertical direct-acting, single-cylinder type, having Richardson's patent valve-gear. The valves are of the Kinghorn type, with gun-metal seats and guards. The pumps are provided with a suitable air vessel.

Aerator.—The aerator consists of cast-iron "A" frames supporting a copper perforated pipe. These "A" frames are connected together by means of light girders at intervals, and fixed to these girders are perforated zinc trays, having sufficient number of perforations to allow of the required amount of water to pass through in a large number of very fine streams. The aerator is fitted with three of these trays. The bottom of the aerator consists of a galvanised sheet-iron tank to receive the aerated water. The end frames of the aerator are boarded in, and the sides are fitted with a number of louvre boards, so arranged that the air can have free inlet and outlet to the water, and that any water splashing on to these boards will run back again into the tank.

Filter.—The filter measures 14 ft. × 6 ft. 6 ins. × 5 ft. 6 ins. deep, and is of sufficient surface to deal with 20,000 gallons of water per hour. The filter tank consists of cast-iron plates. The filter is arranged inside with a rib which supports a couple of filter plates of wrought iron, these filter plates having a sheet of wire gauze in between, and so arranged that the holes in the plates are opposite one another. In that part of the filter below the filter plates a cast-iron pipe is connected to a valve on the outside of the filter. This cast-iron pipe has a large number of 1½ in. wrought-iron pipes branching out under the whole of the filter surface, these pipes having a number of very small holes arranged in them, so that the delivery of air for flushing purposes may be distributed as evenly as possible on to the surface of the filtering material. The filtering material

consists of gravel of special quality, about 18 ins. or 19 ins. deep, supported on the above-mentioned plates.

Heater-condenser.—The heater-condenser is of Row's patent, No. 16A, Class A, consisting of a cast-iron shell, with solid drawn copper tubes, $1\frac{1}{2}$ in. original bore, indented under Row's patent.

Break-tank.—The break-tank consists of wrought-iron galvanised plates riveted together.

DISCUSSION.

Mr. H. P. Boulnois: I have pleasure in moving a vote of thanks to the Author. I have seen the process at Manchester, where the first installation was, I think, put up. I do not think it was quite this system. In that case the water was strained by gravity through felt bags enclosed in wire cages. This is quite a different system from that at Manchester. It is practically a system for the proper filtration and aeration of the water, so that it can be used over and over again. That is a wonderful step in the direction of economy, and of making the bath more attractive. As to the cost of the system I must say I should like more detailed information.

Mr. J. Rush Dixon, Woolwich: I have pleasure in seconding the vote. I think Woolwich is the first instance of the continuous filtration of water having been applied to new baths in London. The installations at Islington and Rotherhithe are applied to existing baths. I should like to congratulate Mr. Angel on having placed before the Association a paper which is most interesting, and particularly so to those who may have nibbled at the subject. The paper leaves a lot to be desired in the way of information, and I agree with Mr. Boulnois that the particulars given as to working cost are very slight; certainly from experience at Woolwich, where the system has been in operation for some time, the figures would not anything like tally. I was one of a deputation which went in November, 1905, to Newton Heath, Manchester, where it was understood the system was first tried. It was there we heard that the first idea of filtration was through felt bags, which became so foul that it was a most nauseous and disgusting operation to clean them, and they had to drop the idea on that account. Then a firm came along with a system of filtering through fine spar or

gravel. We also visited Bury, which was one of the first places to take up Row's method, mainly because their water supply came from a peat district, and was very much discoloured. My Councillors were very greatly impressed when they saw the water delivered from the mains quite brown, and when they went to the swimming-bath, where water had been in use for four or five months, they found it beautifully clear and opalescent. After visiting these and the new Victoria Baths at Manchester, I had to report to my Council, and you can imagine the scepticism with which the report was received by those who knew nothing of the system. After the matter had been considered by our medical officer, it was agreed to allow the system to be installed conditionally on the water being changed once a fortnight. I think I can claim for Woolwich that it has the most complete installation which has yet been introduced into London. The outlay for the filtration and aeration plant has been 1200*l.*, and for staging another 200*l.* We use small spar in the filter. The result so far has been most satisfactory. There is no doubt such a system leads to great economy in the use of water, and it provides for clean water for those bathers who are not fortunate enough to be able to go in when the water is first changed in the ordinary way. To examine the accumulation that comes from the filter would go far to prevent the scepticism which prevails with regard to this system. It is most astonishing to see what can be got out of water after one or two hundred people have been bathing, and I think the prejudice against the idea of re-using so long would soon disappear if the contents of the filters could be seen. I do not observe anything in the analysis which points to the softening of the water, but it is a fact that in Woolwich, where we have a hard water coming from the chalk, this system softens the water a good deal, and makes it better for bathing in. With regard to direct-acting pumps, my experience is that they are somewhat extravagant in the consumption of steam. They consume approximately 250 lbs. of steam per hour, and steam the full stroke, whereas a saving could be made of at least 50 lbs. of steam per hour if there was a flywheel to the pump and a cut-off in the stroke. I do not think it a good thing to use the same filter alternately for two swimming-baths. There are separate filters for each bath at Woolwich, and we have a pump for each. Mr. Angel mentions a break tank for aeration,

which is of great importance, but so far as I can see they have no break tank at Rotherhithe. The object of this is to aerate the water after passing through the filter, and also for cleansing the filters. The water after having been filtered goes into an open flushing tank under pressure, and overflows into bell-mouthed outlets, which convey it to the heaters before going back into the bath at the shallow end. I can only say that Mr. Angel has done most useful service in bringing this system under the notice of the Association. I think it is a system which is worthy of more consideration than it is now receiving, and so far as I am concerned, if it will be any use to any member of the Association, I should be glad to show him the system in working at Woolwich. As to the amount of water and steam used it is most economical, but I have no reliable figures to quote as yet. I am prepared to accept those given so far as they go in regard to Rotherhithe baths, but I certainly hesitate to accept them as applying also to Woolwich.

MR. CHAMBERS SMITH: There is a sentimental objection against using water repeatedly; evidently Bermondsey is not quite a residential district. We have got a very good class of bathers at Sutton, and when it was first proposed to adopt the system, we had very strong opposition to it. "You are going to use this water over and over again for six months," was the objection urged to it. It was pointed out that after six months' or twelve months' use the water was actually purer than when it was received from the town mains. That was not sufficiently convincing to my Council. The medical officer of health opposed it, and the medical men on the Council thought there was objection to it. I do not think that sentimental objection holds good to any one who has seen it in actual working. There is one thing in regard to the cleansing of the bath. We all know there is a deposit on the floor and a growth on the sides of a swimming-bath, which really requires to be cleaned down daily. How is that growth and deposit effectually removed from the bath? Perhaps Mr. Angel will be able to explain that. Altogether the saving is a most important one. Our bath holds roughly 100,000 gallons, and at a cost of 7*d.* per thousand gallons, that is 3*l.* Roughly, it costs us about 10*l.* per week to change the water. The saving on the cost of water is probably 70 or 75 per cent. I think it is a system which requires the most careful consideration and attention, so that

we can advise our local authorities, after due consideration, that an important economy can be effected in the management of public baths.

Mr. E. B. B. Newton: I would congratulate Mr. Angel on a paper which would be more useful if we had a little further information on one or two points. In the table of chemical analysis we might have in a column D an analysis of the water before entering the bath, *i.e.* the water in the main. We might have also information as to the aeration of the water, the method of working and capacity of the filter, and the nature of the filtering materials. It is difficult to formulate any conclusion from the comparison given in the paper of the cost of working the bath before and after the installation of the filters. It is for two different years, and so not a good comparison. The number of bathers and the state of the weather, which has a great influence in the number of persons using a swimming-bath, are not given for each year. I do not think these figures, as between the two years, can give us an accurate idea of the saving in cost in the same year. It would be interesting to know the total annual expenditure on the baths, and what proportion the saving bears to it. In considering the adoption of this suggested method, one has to take into account the number of people it prevents—especially in a high-class neighbourhood—from attending the baths. Whether this system is actually good or not a certain number of persons will not attend public baths, unless they are reasonably sure they are going to bathe in clear water from the main.

Dr. Brown: I have heard a good many objections to this system, but, so far as I can make out, they resolve themselves into one, that is, the sentimental objection. That unquestionably is the chief objection to it. It sounds a very objectionable thing to be constantly using the same water over and over again. Really I cannot see that there is much to be gained by laying too much stress on the sentimental side of the question. If we are going to talk about sentiment, how about the water we drink and the food we eat? I am afraid we would have great difficulty in ever washing our faces, or drinking any water, and be all driven to drink distilled fluids of various descriptions, and we would want all our food sterilised in some way or the other. I am afraid it would not be safe to breathe the atmosphere. What is the sentimental objection? It is

that the water is used over and over again? What is the harm in using water over and over again provided it is cleansed in the interval? People do not hesitate to bathe in the Thames and other rivers where sewage is constantly pouring in. People do not think anything of drinking milk which is teeming with bacilli coli more than in this water. Even our water supply in London is not free from bacilli coli. We are drinking these coli every day, although they may not be in such quantities as in this bath. But they undergo filtration, and our London water we do not drink as Thames water, but as water which has undergone filtration. I do not agree with keeping the water in the bath nine months; that was done to try the worst effect. It might have confirmed one's position if we had had more analyses. But in any case these analyses, taken on the whole, are what one would expect. I need not deal with colour; the colour is improved. It cannot be questioned that, as regards suspended matter, it is improved, because it is free from suspended matter. As to odour there is none in any of the samples. The total solid residue and loss on ignition I need not deal with. Combined chlorine is of some importance, as increase of chlorine may be taken to represent in some way urine which gets into the water. You will see there is a slight increase in this. That is what you would expect. There may be a certain amount of urine get into the bath, but not much. The chlorine as chloride is a comparatively harmless thing; it cannot do any harm except from a sentimental point of view. The important thing is nitrates. If there is any organic matter it gets altered in character, as it is generally undergoing a process of oxidation, and in the ordinary course these nitrogenous products are disintegrated into ammonia and then into nitrates. There is a great increase in nitrates—about twenty times as many as before the plant was erected, and more than twice as much in the second analysis of the filtered water. Nitrates cannot possibly do any harm. If you found a quantity of nitrates in a drinking water you might wonder where they came from, and regard them as showing a source of pollution, but in a swimming bath they are perfectly harmless. Saline and free ammonia are slightly increased, and there is a further increase in the second analysis. This is a more or less unstable condition, and I do not lay stress on it, as it depends upon the state of the filter. The albuminoid ammonia has slightly

increased. The oxygen absorbed is nothing unusual. The bacteriological examination is not so important as appears on the surface, as the number of bacteria is a constantly varying quantity, varying from hour to hour according to the heat of the bath and the number of bathers. The important fact is that bacteriologically the water does not get worse. You must expect some impurity, especially in a district where the population is not among the most aristocratic. The water in these circumstances often gets dirty and disgusting in one day. The bottom gets covered with a dark layer, and has the appearance of being dirty. In a place like Westminster the water will get dirty in a day in the summer time. It seems to me the proper way to look at it is this: you are between two things. If you are prepared to have a stream of perfectly fresh, pure water from the Metropolitan Water Board's main going through the bath continuously every day well and good; I should prefer that myself, but you have got the expense to consider. If you can fill your bath every day, I agree that would be the best thing to do, but you are met there by expense, and it seems to me it is a question between expense and the getting the best method you can. By this method the water never really gets dirty at any time, no matter how many bathe in it, and it is equally clean for all the bathers. In the Camberwell baths they tried an experiment there of using well-water. The spa used there has got a certain amount of iron in it. The result is, when you get the bath filled with the spa water you cannot see the bottom of the bath, and when any one dives in he is lost to sight. After two days you get an iron precipitate at the bottom.

MR. J. E. BOAZ: It strikes me that there is one thing which cannot be removed from the water by any system of filtration or aeration, and that is anthrax.

MR. SUMNER: I am more perplexed than ever after hearing Dr. Brown. He has stated that he does not believe in keeping the water in the bath so long, though the analysis is perfectly satisfactory. Is it really only a question of sentiment with Dr. Brown, or is it that he really doubts the analyst's figures?

THE CHAIRMAN: In regard to this paper, I do not wish to say very much, but there are one or two points which occurred to me. Attention has been called to the absence of the coal account in the comparison of cost of the two systems. That, as

I understand it, is because the cost of coal seems to be the same in both systems. I had the same experience, though not the same comparison. In one of our baths we had been using main water, and had to heat it by circulation. Then we put down a deep well, from which we drew our water, and after a year we found that the cost of coal to pump up the water from the deep well was practically the same as the former cost of heating the water. As I understand the position, it costs about the same to pump the water through the filtering apparatus as it does to heat the water supplied from the main. It costs us about as much to pump the water from the chalk as to heat the water drawn from the main. My preference is naturally for the clean water from the chalk. My Council had this process under consideration, and on the basis of sentiment they would not adopt it. I think it is entirely a matter of sentiment. There is a good deal in what Dr. Brown said. If we worried about the microbes in the air we breathe, in the water we drink, and the food we eat we should have a very worried life, and he treats the analyses in the same way. There is a certain amount of actual nitrates, and ammonia, but they will not do anybody any harm. They are good enough to bathe in; you do not drink the water.

Dr. Brown: I do not think that filtration, or any process like it, would destroy anthrax spores. Even if they were in the bath, I think they would be destroyed naturally in the course of a very short time. These spores would be developed into bacilli, which would die out. The best answer is that they would be most unlikely to be there. In reply to Mr. Sumner, I think it would be a concession to sentiment if I wanted the water changed every fortnight, but to want it changed every quarter is not a concession to sentiment. I do not think the floor and sides of the bath could be thoroughly cleansed without the bath being emptied, and, for that reason, I think it is advisable to have the water changed at least once a quarter.

The vote of thanks to Mr. Angel having been unanimously accorded,

Mr. R. J. Angel, in reply, said: With regard to the remarks of Mr. Boulnois as to the use of felt bags at Manchester for cleansing the water, they became so terribly offensive that the men refused to go on with the work. But that does show the benefit which accrues from filtration. If

that filth was in the water instead of the bags, it would be very offensive to bathe in. I left the question of coal out because there was no real difference in cost. Mr. Dixon referred to the quantity of steam used, and that it would be an advantage to use a flywheel. I agree with him. As to the alternate use of the filter for the two baths, I admit that I would prefer to put down a separate filter for each bath and work them continuously. The break-tank was not put in. A tank was already in use, and we utilised that for a break-tank. Mr. Chambers Smith mentioned the cleansing of the sides and bottom of the bath. The attendants have brooms weighted with lead, with which they brush the sides and bottom of the bath, disturbing any accumulation there, and then the apparatus is put on full pressure, and the whole of the water is changed. When that is done daily, you will quite see that only a small accumulation can take place. Mr. Newton asked for an analysis of the water before it enters the bath. That would be simply an analysis of the ordinary London drinking water. The description of the filter is set out in the paper. As to the difference in the number of people using the bath before and after this system was installed, we have not noticed any change whatever except that caused by climatic conditions. We have another bath in Bermondsey, and have not noticed any addition to the number of bathers there, which would have been the case if they had preferred the unfiltered water taken from the main and renewed frequently. As to the cooling of the water when it gets out into the open air, during the severe frost we took notice of that, and we found it is only in the open air about one minute, and during that time it drops only two degrees in temperature. It is chiefly the sentimental reason which prevents us from using the water for a long time. We give the bath a thorough scrape down with spirits of salts when we empty it.

Light refreshments were served at the close of the business proceedings.

HOME DISTRICT MEETING.

May 2, 1908.

Held in the Worple Hall, Wimbledon.

W. Nisbet Blair, M.Inst.C.E., Vice-President, *in the Chair.*

The Mayor (Mr. S. R. Collier, M.D.) received the members and offered them a cordial welcome to Wimbledon.

The Chairman thanked the Mayor for the welcome he accorded.

MUNICIPAL WORKS RECENTLY CARRIED OUT AT WIMBLEDON.

By C. H. COOPER, M.Inst.C.E., Borough Engineer, Wimbledon.

The Association has visited Wimbledon on three previous occasions, viz. on September 28, 1889, when they were received by the late Mr. W. Santo Crimp, then Engineer and Surveyor to the Wimbledon Local Board, who subsequently attained that world-wide fame which a man possessing his abilities deserved. In addition to abilities, Mr. Crimp had that thorough sincerity and charm of manner which endeared him to all who were fortunate enough to possess his acquaintance. His death, at the early age of forty-seven, was a great loss to the branch of engineering which we practice, and especially so from his capacity for research,

The second visit was made on April 30, 1898, and the third on March 16, 1901.

Those members who visited the district on these dates will, no doubt, agree that on each occasion there were many new works to be seen, and it is hoped that to-day's meeting may not be without interest to those who have taken the trouble to attend.

The Author's remarks will be confined mainly to works carried out since the last visit of the Association to Wimbledon, and the following table will show the growth which necessitated these works:—

Year ending March 31.	Population.	Mileage of roads repairable.	Electrical output in units.	Amount of loans sanctioned during year.	Total indebtedness.	Rateable value.	1d. in the £ produces
							£
1902	44,246	35·75	889,027	69,738	312,567	314,468	1222
1903	46,162	37·00	1,157,084	39,004	330,152	327,561	1267
1904	47,719	37·66	1,283,060	24,332	336,661	341,616	1333
1905	48,240	39·75	1,499,958	29,118	359,391	373,587	1378
1906	49,860	41·20	1,801,075	31,718	348,783	381,610	1437
1907	51,714	42·83	2,084,434	65,106	363,111	402,281	1483
1908	—	44·76	2,819,317	45,112	385,830	410,520	1514

TRAMWAYS.

In the Session of 1902, a Bill was introduced into Parliament by the London United Tramways (1901), Ltd., which provided for tramways in this district. The Author was well posted in the difficulties experienced by brother surveyors in neighbouring districts in dealing with the Company, which placed him in the somewhat unique position of being forewarned, and, under his advice, two clauses were inserted in the section of the Bill protecting Wimbledon—the one empowered the Corporation to prevent the running of tramcars until the widenings shown on the deposited plans had been carried out to the full extent; under this clause an area of no less than 3·11 acres has been added to the highways free of cost to the Corporation. The other clause provided that where the tramways passed over or interfered with any sewer which, in the opinion of the surveyor, it would be dangerous or inconvenient to retain in its position, the Company, at their own expense, were to take up such

sewer and relay the same in a portion of the road not occupied by the tramway. To liquefy this liability the Company paid to the Corporation the sum of 5000*l*.

These tramways traverse a route within the borough of 3·637 miles, which, with the exception of 0·86 miles, is in double track, whilst 0·88 miles lie alongside the borough boundary. The lines are connected with the remainder of the London United Tramway Co.'s system, which has a length of 54 miles, connecting up the districts of Shepherd's Bush, Hammersmith, Acton, Ealing, Chiswick, Kew, Brentford, Isleworth, Hounslow, Twickenham, Teddington, Hampton, Kingston, Surbiton, New Malden, Wimbledon, Merton, Mitcham, and Tooting. The lines are worked on the overhead system, with a voltage of 500, direct current, the track being laid with 100-lb. rails, with a cross sleeper rail at 6 feet apart. The rails are laid on a bed of concrete, 6 inches thick, which extends to the entire width of the part of the roadway maintainable by the Company. The joints between the rails, in addition to fish plates, have a sole plate, 2 feet 6 inches in length and 8 inches deep. The track, with the 18-inch margin on either side, has been laid with Karri and Jarrah blocks in pitch, and grouted in with cement, at such a level as to allow of cross falls of ⅜ inch to the foot on the margins on either side. In one case only has the Corporation seen fit to pave these margins with wood.

PUMPING PLANT.

The method of raising sewage at the two main pumping stations (Durnsford Road Sewage Works and Raynes Park) has been altered from reciprocating pumps, driven in the former case by steam, and in the latter case by gas engines, to centrifugal pumps placed horizontally and driven by vertical shafts direct from motors placed above ground, whilst the pumps are placed in chambers at levels approximating that of the sewage in the pump wells.

The current supplied for driving motors in this department is single-phase, alternating, the voltage being 440, and the price charged 0·90*d*. per B.T.U.

In the case of Durnsford Road Pumping Station, the former plant consisted of two double-plunger, single-acting, pumps,

the plungers being 2 feet 1 inch in diameter with 4-feet stroke, capable of raising 4000 gallons per minute. These pumps, which were erected in 1875, were not sufficient to deal with the sewage due to the increase in population. The present plant consists of two 22-inch and one 12-inch centrifugal (Worthington) pumps, each of the larger pumps being driven by a 115-B.H.P. British Thomson-Houston motor, and are capable of raising 8000 gallons per minute, with a head of 24 feet. These two pumps are only intended for use in times of maximum flow and storms. The smaller pump is a 12-inch Worthington centrifugal pump driven by a 25 B.H.P. British Thomson-Houston motor, and is capable of raising 1500 gallons per minute. The combined efficiencies are as follows, including loss in the motors:—

	22-inch Pumps. Per cent.	12-inch Pump. Per cent.
At full load	65·7	60·9
„ ¾ „	60·3	56·5
„ ½ „	52·8	46·2
„ ¼ „	44·0	37·5

In the case of the Raynes Park Pumping Station, the former plant consisted of two 3½ H.P. "Otto" Gas Engines capable of raising 400 gallons per minute. The present plant consists of two 6-inch (Worthington) centrifugal pumps driven by 7½ B.H.P. Brush Electrical Company's motors, and are capable of raising 400 gallons per minute each, *i.e.* twice what the former pumps raised, with a head of 31 feet. The combined efficiencies are as follows, including loss in the motors:—

	Per cent.
At full load	54·0
„ ¾ „	50·0
„ ½ „	39·0
„ ¼ „	26·5

The pump impellers are of the enclosed type.

As the former pumps at both these stations were in a bad condition, the plant had to be installed before the screens were erected, and considerable difficulty was experienced in consequence. The screens that have been adopted are those of Messrs. S. S. Stott and Co. of Haslingden, Lancs., these are electrically driven.

In connection with the sewage works, since the last visit of the Association, 5 acres of bacteria beds have been added.

The beds consist of burnt ballast 3 feet in depth, screened on a ⅜-inch mesh hand sieve; the material passing through the sieve forms the top 9 inches of the beds, whilst the larger material forms the bottom layers of the beds. The subsoil drains are laid at a distance of about 6 feet apart; these discharge into an open concrete channel; the upper ends of the drains are carried above the ground so as to form ventilators which, when a bed is not in use, allows a free circulation of air through such bed. These beds are charged twice in 24 hours.

Four settling tanks, each having a capacity of 212,000 gallons, were constructed in 1902. These tanks are 110 feet in length by 30 feet wide, the sludge outlet being placed at a distance of 20 feet from the end where the raw sewage is admitted. The depth varies from 10 feet to 14 feet.

The sewage and effluent from each of the processes, *i.e.*

from the settling tanks,
„ 1st run bacteria beds,
„ 2nd „ „ and
„ irrigation plots,

is analysed daily by the Assistant Farm Manager, Mr. C. Austin Snook, the average monthly analysis for last year being as follows:—

Year 1907.	Oxygen absorbed per 100,000 parts.	
	By raw sewage.	By final effluent.
Month.		
January	8·074	0·259
February	3·691	0·364
March	3·486	0·263
April	3·289	0·264
May	3·170	0·290
June	3·227	0·199
July	2·481	0·149
August	2·688	0·255
September	3·349	0·213
October	3·089	0·269
November	2·849	0·443
December	3·266	0·168

AIR-COMPRESSING PLANT.

The air for sludge-pressing and driving two ejector stations was formerly pressed by—

One Johnson's double-acting twin compressor working 40 strokes per minute, and having 12-inch diameter steam-cylinder and 9-inch diameter air-cylinder, with 20-inch stroke; and a

Goddard, Massey and Warner's double-acting compressor, having a 12-inch diameter steam-cylinder and 8·2-inch diameter air-cylinder, 16-inch stroke, making 132 strokes per minute.

The plant has been replaced by—

Three Lacy-Hulbert & Co.'s air-compressors, belt-driven by three General Electric Company's single-phase induction motors.

COMPRESSORS.

		Diameter of piston.	Stroke.	Revolutions per minute.	Cubic feet of air at atmospheric pressure, pressed to 100 lbs.	Mechanical efficiencies of compressors.
A.	Double acting	8"	7"	190	150	84
B.	"	8"	7"	165	130	84
C.	"	6¼"	5"	175	30	72

MOTORS.

	H.P.	Revolutions per minute.	Efficiencies at full load per cent.	Combined efficiencies.
A.	30	725	86	72
B.	25	725	86	72
C.	8	725	84	60·8

Recreation Grounds.

Although Wimbledon, on the north-west, has the advantage of 583 acres of the Common, a large portion of the population cannot avail itself of the facility of such open space, and the Local Authority has provided, in adddition, six recreation grounds, having an area of 54 acres. Wandle Park, where it is proposed to have lunch, was acquired by the Corporation in 1907, and was opened by Her Royal Highness Princess Louise, Duchess of Argyll, on July 11, 1907. The area of the portion of the park purchased by the Corporation is 9·70 acres, but owing to Mrs. Richardson Evans having acquired the mill-pond

and grounds connected therewith, having an area of 2·25 acres, and which she has presented to the National Trust as a memorial to her late brother, Mr. John Feeney, who for many years was connected with the *Birmingham Post*, this park may be said to have an area of 12 acres.

The park is of considerable historical interest, as it joined, and in all probability at one time formed part of, the celebrated Abbey of Merton. It belonged at one period to Mr. Perry, who was a London banker and the proprietor of the *Morning Post*, and who was in the habit of entertaining King George the Fourth and Lord Nelson at the house in which you will, to-day, have lunch. The park is also interesting from an engineering point of view, as the iron road, constructed to take Sussex iron to the Wandsworth Ironworks, ran through the garden, which is now laid out for the purpose of teaching horticulture to children.

WIMBLEDON ELECTRICITY UNDERTAKING.

By H. TOMLINSON-LEE, A.M.Inst.E.E.

The Urban District Council of Wimbledon obtained from the Board of Trade, in 1897, a Provisional Order for an electricity supply scheme in their district, and the supply for private and public lighting was inaugurated on July 17, 1899. In 1903 a further Order, named the Wimbledon Electric Lighting Extension Order, was obtained, authorising the inclusion of the adjoining parish of Merton in the area of supply. The total extent of the combined areas is 4985 acres, and the estimated population is 60,000.

The consulting engineer for the original scheme, Mr. A. H. Preece, A.M.I.C.E., read a paper thereon before you in 1898. The Author, therefore, does not propose to refer to the works as originally constituted, but to confine himself to a description of them as they at present exist.

System.

The high-pressure alternating current, single-phase, system of generation is employed. The high-pressure, or primary, voltage is 2000 to 2500 volts, the periodicity being fifty complete cycles per second. Transformer sub-stations, for reducing this primary pressure to the low pressure, or secondary, voltage of 220 and 440 volts for distribution, are built in different parts of the supply area. The Author will refer more fully to the distributing system in another part of this paper.

Buildings.

The buildings consist of an engine-room of two bays, a boiler-house of two bays, offices, staff-house, stores, workshop, circulating-pump house, the refuse-destructor house, and

tipping platform. With the exception of the original engine-room and boiler-house, now the refuse-destructor house, which now form a very small part of the works, the whole of the buildings have been designed by Mr. C. H. Cooper, M.I.C.E., the Borough Surveyor, and erected under his superintendence.

There are two chimneys, one 175 feet high from the ground level, with an internal diameter of 11 feet, built on the Custodis principle, and the other 96 feet high from the ground level, with an internal diameter of 6 feet.

The offices are commodious and conveniently arranged, and the rooms over them are used for the accommodation of the members of the technical staff.

Engine-room.

In the engine-room there are seven steam-driven alternators, particulars of which are given in the following table:—

No.	K.W.	I.H.P.	R.P.M.	Type of alternator.	Type of engine.	Exciter.
1	120	150	365	Crompton-Brunton with revolving armatures	Willans 3-crank compound	Direct coupled
2	120	150	365	Ditto	Ditto	Ditto
3	120	150	365	Ditto	Ditto	Ditto
4	350	550	333	Ditto	Ditto	Ditto
5	350	550	333	Ditto	Ditto	Ditto
6	625	900	300	British Thomson-Houston with revolving field magnets	Browett-Lindley 3-crank compound	Ditto
7	1000	1800	1500	Ditto	Curtis vertical turbine	Separate motor-driven.

The whole of the reciprocating engines—Nos. 1 to 6—exhaust into a surface condenser, situated in a pit at the end of the engine-room, having a cooling surface of 3400 square feet, and capable of dealing with 35,000 lbs. of exhaust steam per hour. An oil-separator and a grease extractor are installed in connection with this condenser. The condensed steam is discharged into the adjacent hot-well by steam-driven twin air-pumps and a monotype air-pump.

The turbo-alternator has its own condensing plant, consisting of a Worthington surface condenser, having a cooling surface of 3000 square feet, with a three-throw motor-driven air-pump, which discharges the condensed steam into the before-mentioned hot-well.

There are two hand-operated overhead travelling cranes in the engine room. That over the reciprocating sets has a lifting capacity of 5 tons, and that over the turbo-alternator has a lifting capacity of 15 tons.

The main high-tension switchboard, mounted on a gallery at one end of the engine-room, is of a cellular type. There are seven generator panels, an interconnector panel, and ten feeder panels, with the usual indicating and measuring instruments. The exciting switch-gear is mounted in front of the generator panels. In connection with this main switchboard there are two sub-fuseboards—fixed on the wall facing the 120 K.W. sets—controlling the street-lighting circuits and the power circuits for the works and sewage pumping station.

Circulating Pump-house.

The circulating pump-house is situated at the rear of the workshop. It contains at present two centrifugal circulating pumps, each coupled direct to a 45 B.H.P. single-phase motor, the switchgear for which is mounted on a gallery above the pumps. The circulating water for the whole of the condensing plant is obtained from the river Wandle. It flows by gravity from the river to a well immediately underneath the circulating pumps. These pumps are capable of delivering 2000 gallons of water per minute to the condensers, through approximately 140 yards of 22-inch delivery pipe; the maximum pump suction is 9 feet 9 inches, and the total static head about 28 feet.

The circulating water, after passing through the condensers, returns to the river by gravity.

A 2-ton overhead travelling crane, operated by hand, traverses the circulating pump-house.

Boiler-house.

The boiler-house contains eight water-tube boilers having a total heating surface of 24,077 square feet. Three of these

boilers—Nos. 1, 2, and 3—are hand-fired with Welsh coal, the remainder being fitted with Bennis patent mechanical stokers and compressed air furnaces. These stokers are operated by motors through overhead shafting and belting. The coal used is Midland small nuts, having a calorific value of about 13,000 B.Th.U.

There are two Green's economisers, one of 128 tubes connected with Nos. 4, 5, and 6 boilers, and one of 320 tubes connected with Nos. 7 and 8 boilers, three Weir feed pumps and two Worthington feed pumps. Attached to the flues are two combustion recorders for recording the percentage of carbon dioxide (CO_2) in the flue gases. Since their installation, the Author has been able to detect and remedy various irregularities, with the result that the coal is now burned more economically.

Coal is brought into the works direct over a siding from the main line of the L. and S. W. Railway. The trucks are hauled over a weighbridge and up on to a turntable at the workshop end of the overhead railway, which runs the whole length of the boiler-house between the two lines of boilers. The coal is deposited on the floor under the railway, and fed into the stoker hoppers by hand.

The gases from Nos. 1, 2, and 3 boilers are carried off by the small chimney, and those from the other boilers are carried off by the main chimney.

Water-softening Plant.

Adjoining the main chimney is a water-softening and storage plant. The softener is capable of softening continuously 4000 gallons of water per hour, the process being as follows: The water to be softened is pumped from the circulating pump-house well, by a Worthington turbine pump direct coupled to a single-phase motor, to the softening tank, where it is mixed with the soda softening re-agent and clear lime water. From this tank the water passes to a precipitation chamber, then through a wood wool filter, and finally, before being discharged into the storage tank, it passes through a quartz sand filter which removes all finely suspended matter. The whole of the softening and filtering system is contained in the tower alongside the storage tank. The initial hardness of

the water is about 24 degrees, which is reduced by the treatment to about 8 degrees at a cost of approximately *4d.* per 1000 gallons. The storage tank has a capacity of 30,000 gallons.

WORKSHOP.

The workshop adjoins the boiler-house, and is immediately under the coal-hauling platform. The Author has installed an equipment of machine tools electrically driven through overhead shafting. The whole of the mechanical repairs are carried out in this workshop.

STORES.

The Stores are situated under the tipping platform and adjacent to the refuse destructors. They are very complete, a good stock of spare parts for the various machines in the works being kept.

REFUSE DESTRUCTORS.

The refuse destructors are of the Beaman and Deas top-feed type. They consist of four cells connected to two water-tube boilers, having 3580 square feet of heating surface. The maximum capacity of these destructors is 21,000 loads of house refuse and 2700 loads of sludge cake per annum. Forced draught is obtained by means of a centrifugal fan driven by a small steam engine. It was originally intended that the steam raised in the boilers attached to these destructors should be used for driving the engines in the electricity works, but after about two months' running this was found to be impracticable, and the cells were shut down, the boilers being hand-fired with Welsh coal.

In 1902, in consequence of the removal of the original coal-fired boilers from the destructor house, the Author was enabled to effect some much-needed improvements in the destructor cells, and they were again set to work on June 1 of that year. The steam raised was used for driving the engines of the sewage pumping station, and at present it is employed for heating the Isolation Hospital and driving the machines installed there.

Distributing System.

The distributing system is very extensive. High-pressure mains run from the works to the main sub-stations, and from these main sub-stations to the minor sub-stations. The whole of these high-pressure feeders are interconnected. The current is transformed in the sub-stations to a pressure of 220 volts for private, and 440 volts for public, supply.

The high-pressure mains are concentric, paper-insulated, and lead-covered; they are drawn into stoneware conduits, each cable being isolated.

The private lighting low-pressure cables are concentric, paper-insulated, lead-sheathed and armoured, and they are laid direct in the ground.

The public lighting low-pressure cables are three-core, vulcanised indiarubber, lead-sheathed and armoured, and they are laid direct in the ground. A pressure of 440 volts is maintained between the outer conductors.

The house-service cables are twin, paper-insulated, lead-sheathed and armoured, and the public-lamp service cables are twin, vulcanised india-rubber, lead-sheathed and armoured.

The total mileage of mains laid to date is as follows:—

High-pressure mains for private and public supply ...	45·3	miles.
Low-tension private distributing mains	78·0	„
Low-tension public lighting mains	48·0	„
Low-tension private and public lighting service cables ...	27·6	„
Total ...	198·9	„

There are twenty-eight sub-stations, both under and above ground, and six transformer pits, with a total capacity of transformers installed of 2455 kilowatts, the average capacity of each sub-station being 83 kilowatts, and of each pit 21 kilowatts. The present capacity of the largest sub-station is 225 kilowatts.

The Author has re-designed and enlarged practically the whole of the sub-stations; they are now up-to-date, and comply with the regulations of the Home Office and the Board of Trade.

In order that the Engineer-in-charge at the works may be cognisant at any time with the private lighting low-tension pressure in the various parts of the supply area, fifteen of the principal sub-stations have recently been connected with the

works by means of a system of pilot wires. These wires are brought to a central point in the engine-room, and there connected with fifteen voltmeters, one for each sub-station. These voltmeters are fitted with recording charts, which are renewed every twenty-four hours, and indicating scales.

Public Lighting.

The public-lighting system is entirely separate from the private-lighting system, the mains being "dead" during the day. The whole of the lamps are controlled from the works, being switched on simultaneously in the following manner: The public-lighting feeder is switched in on the main switchboard, a separate alternator being then run up on it; when up to the proper speed and pressure, this alternator is paralleled with the other machines running on the private-lighting load. When the public lighting is switched off, this operation is reversed, the alternator being separated from the private-lighting machines, and then gradually shut down.

All the main roads and important cross-road junctions in Wimbledon are lighted by 98 flame arc lamps, each giving approximately 2700 candle-power, and consuming 500 watts per hour. The side roads are lighted by incandescent electric lamps, there being 1036 posts, with two 16-candle-power lamps in each lantern.. Forty-three hot-wire Foster arc lamps, giving approximately 1200 candle-power, and consuming 600 watts each, have been erected on the Ashen Grove Estate, a part of Wimbledon which is being rapidly developed. Each lamp is protected by its own fuses.

Experiments with metallic filament lamps for side street lighting have been carried out. The results obtained with the Osram lamp have been very satisfactory, and it is probable that the whole of the side streets may eventually be lighted by them.

The charge for street lighting is 2¼*d.* per unit, which includes attendance and cleaning. The total charge for the past year was 5994*l.* 15*s.*, or approximately 5*l.* 11*s.* 10*d.* per post.

Commercial Statistics.

The annual accounts of the undertaking afford striking proof of its phenomenal success, and the Author trusts the following analysis of the yearly returns will prove interesting :—

Year.	Capacity of works in k.w.	Capital expended.	Total revenue.	Total expenditure.	Profit or loss.	Units generated.	Units sold.		Average price obtained per unit sold.	Total cost per unit sold.	Number of consumers.	Private 8-c.p. lamps connected.	Public lamps.		Max. load in kw.
							Private.	Public.					Arc.	Incandescent.	
		£	£	£	£										
1900 (8 mths.)	360	41,004	2,671	3,711	1040 –	181,401	100,613	53,629	4·05	5·69	253	13,965	—	554	198
1901	360	57,703	9,508	9,374	134 +	724,028	229,117	415,304	3·48	3·30	459	24,051	—	903	367
1902	1060	85,963	13,239	11,881	1358 +	889,027	360,269	446,011	3·86	3·22	705	33,504	—	1025	510
1903	1060	100,201	15,472	13,444	2028 +	1,157,084	500,816	511,152	3·57	2·98	978	50,170	4	1087	603
1904	1060	115,746	18,640	15,700	2940 +	1,283,060	653,305	539,673	3·65	2·98	1254	64,158	6	1104	772
1905	1685	136,099	20,619	17,776	2843 +	1,499,958	801,459	507,769	3·65	3·25	1625	78,194	42	1059	1012
1906	1685	152,538	22,084	21,745	*338 +	1,801,075	933,880	617,670	3·34	3·14	2011	91,971	48	1077	1050
1907	2685	169,682	24,230	20,776	3453 +	2,084,434	1,152,695	611,208	3·26	2·81	2551	119,291	62	1081	1311
1908	2685	180,514 (Est.)	29,236 (Est.)	25,630 (Est.)	3606 + (Est.)	2,819,317	1,732,560 (Est.)	639,440	2·96 (Et.)	2·59 (Es.)	3087	137,200	141	1036	1548

* After deduction of accrued interest to end of financial year amounting to £1351 9*s*. 7*d*.

The net profit earned by the undertaking to March 31, 1907, has been apportioned in the following manner:—

	£	s.	d.
Applied to the relief of local rates	4,350	7	5
Placed to the credit of a reserve fund	6,621	18	1
Transferred to a suspense account to await allocation ...	2,123	10	2
Total ...	£13,095	15	8

System of Charging.

The present charge for electricity supplied to all consumers for lighting purposes (including that supplied to religious and charitable institutions, public buildings), etc., is:—

(a) For all units consumed up to but not exceeding 400 units per quarter	4½d. per B.T. unit
(b) For all units consumed in excess of 400 units but not exceeding 800 units per quarter ...	4d. " "
(c) For all units consumed in excess of 800 units per quarter	3½d. " "
The present charge for electricity supplied for power, up to 2 H.P., and for cooking, heating, or other special purposes, when installed on a separate meter is...	2d. " "
The present charge for electricity supplied for power (2 H.P. and upwards) when installed on a separate meter is...	1¾d. " "

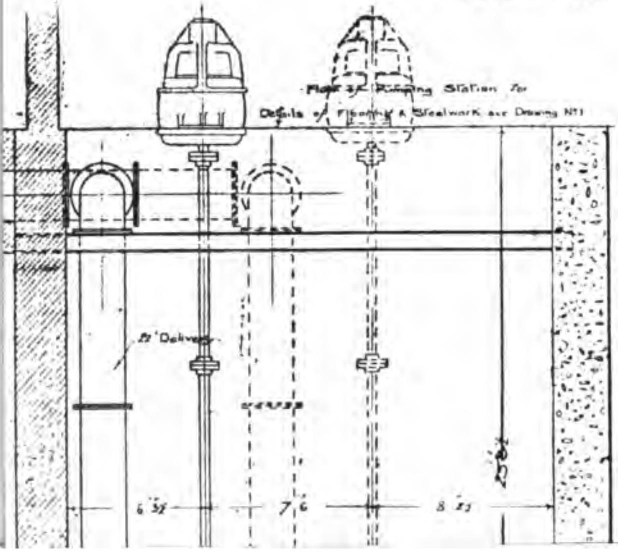
In any case where small motors, cooking apparatus, heaters, etc., are installed requiring less than 220 watts, energy will be supplied only at lighting rates.

The charge for hire of a meter is 1*s.* per quarter, except in the case of a consumer whose account for energy supplied during any quarter amounts to 5*s.* or upwards per meter, when no charge is made.

Extensions.

The following extensions will be carried out during the present year: The generating machinery will be increased by the addition of a 1000 kilowatt turbo-alternator with condensing plant. A main high-tension, remote-control switchboard, having nine machine panels, an interconnector panel, sixteen feeder panels and exciting gear; two water-tube boilers with

PLATE NO. 1.



R COMPRESSOR.

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chain-grate mechanical stokers, Weir feed pump, and an economiser of 320 tubes, will also be erected. The total cost of these extensions is estimated at 17,600*l.*, and they will be carried out in accordance with the specifications of the Author, and under his superintendence.

A new and modern refuse destructor is also to be erected on a site adjoining the railway siding, but distinct from the electricity works. The plant will be of the back-feed type, and will be capable of destroying 84 tons of refuse and 28 tons of sludge cake per day of twenty-four hours. It will be erected in accordance with a scheme prepared by the Borough Surveyor, Mr. C. H. Cooper, and the Author, and the estimated cost, including a chimney 180 feet high by 8 feet internal diameter, will be 9750*l.*

Curtis Turbine.

In view of the increasing interest in turbo-generating plant, the Author hopes the following brief description of the Curtis vertical turbine at the works will not be out of place:—

The turbine is of the three-stage type; the first stage contains three sets of revolving buckets, the second and third stages two sets each. In each stage the bucket rings are bolted in a single cast steel disc. There is one shaft, which serves for both the turbine and the alternator. Between each stage is a diaphragm, and on them are fixed gun-metal packing sleeves, grooved on the inside; also where the shaft passes through the first stage, a packing, consisting of three carbon rings each made up in three segments and held together and against the shaft by a garter spring, is inserted.

No packing is required at the bottom, or low-pressure, end of the shaft, as the step-bearing water is discharged into the steam space.

No by-pass valves are provided in any of the stages. With steam at a pressure of 150 lbs. per square inch, superheated to about 125° Fahr. and exhausting to a vacuum of 1 lb. absolute pressure, the pressure in the various stages is approximately as follows:—

First stage	3 lbs. per square inch above atmosphere.
Second stage	vacuum 20 inches.
Third stage	vacuum 28 inches.

The step-bearing consists of plain cast-iron blocks, the upper one being fixed on the end of the shaft. The lower block is supported on four gun-metal screws, geared together and operated from the outside by a pair of chain wheels and a chain. The water pressure in the step-bearing is about 225 lbs. per square inch at full load. Four to five gallons of water per minute are required to lubricate this bearing, while the guide bearings require about three gallons of oil per minute. This oil is returned to a cooling tank, and is used over and over again.

The average total clearance between the stationary and moving parts of the turbine is about 0·13 of an inch.

The turbine is fitted with hydraulic controlling valve gear. It consists of a hollow piston valve working inside a liner, around the circumference of which passages are cored communicating with the various sections of the first-stage nozzles. These passages have openings into the interior of the liner, and the piston valve, which is actuated by a hydraulic ram, in moving up or down, uncovers or covers these openings in succession, thus regulating the number of first-stage nozzles in action. The ram is operated by water at the foot-step bearing pressure, and is controlled by two small pilot valves operated by the governor.

An emergency valve is placed on the top of the liner. It is of the mushroom type, so arranged as to be able to immediately cut off steam from the turbine. It is normally held open by steam pressure on the underside of a small piston on the valve spindle, the upper side of which is connected to the exhaust. In this position it compresses a strong spring, which closes the valve when equality of pressure is obtained on both sides of the piston, by the admission of steam to the upper side of this piston through a small pilot valve. This emergency valve is always fully open when the turbine is up to full speed and the controlling piston is at its lower or no-load position.

To prevent a sudden demand of water for the foot-step bearing operating gear robbing the step blocks of lubricant a spring-loaded ram accumulator is provided. It is connected to, and supplied by, the foot-step bearing supply pump.

L. AND S. W. RAILWAY RECONSTRUCTION OF BRIDGE OVER RIVER THAMES AT RICHMOND.

By A. W. SZLUMPER, M.Inst.C.E.

This bridge crosses the river Thames in three spans, each of 100 feet. It is approached on the Surrey side by a brick viaduct, and terminates on the Middlesex side by a brick span crossing a public road.

Formerly, the river openings consisted of cast-iron arches, three to each line, carried on brick piers, with a timber superstructure of oak joists and decking.

The work of reconstructing all bridges of cast iron has been systematically carried out by the L. and S. W. Railway Company for many years.

Some years ago, as a temporary measure, an extensive system of wrought-iron ties was inserted to Richmond Bridge, bracing all the ribs together. Early in 1906 the structure showed further signs of weakness, and it was decided to proceed with the reconstruction.

The first operation consisted of driving piles in clusters close to the old structure, placing bearing-girders on the same, just clear of the soffit of the cast-iron ribs and at right angles to the same, then placing temporary main girders on these bearing-girders parallel to the ribs, one immediately under each running rail; they were wedged up tightly to the superstructure, and thus the cast-iron ribs were relieved of the bulk of their load. The three spans were divided up into eleven spans, varying from 16 feet to 60 feet, this latter being a requirement of the Thames Conservancy, so as not to impede the traffic in the river.

The design of the new bridge consists of steel ribs, four to each opening, 102 feet $8\frac{5}{8}$ inch span, $2\frac{1}{2}$ feet deep, and bearing on cast-steel pins, 9 inches diameter, open spandril work

(following as near as possible the old design), and cross girders and deck plates.

The contract for the removal of the old cast-iron ribs and the provision and erection of the new ironwork was placed last May, and operations were started last August, when single-line working was established over the bridge.

Owing to the heavy traffic, the only time the line can be blocked altogether is early Sunday mornings, and then but for about five hours.

The old ribs were bolted together in sections.

A week was occupied in preparing a span for removal, and this was accomplished on Sunday mornings.

The ribs were lifted from their bearings in sections by cranes, and placed on timber-trucks and conveyed to the Railway Company's works at Nine Elms for breaking up and use in the cupola.

As the ribs were removed, the work of cutting away and preparing the abutments and piers for receiving the new bearing-boxes and steel pins was taken in hand, and the erection of the new steel ribs and superstructure proceeded with. These new ribs were delivered in small sections, and unloaded at the site on Sunday mornings, the bolting up, riveting, etc., proceeding during the week.

The new ironwork under the line out of use was completed and opened for traffic on March 1 last, the running line being slewed on to this new portion on this date.

The operation for the removal of the old cast-iron ribs, etc., under the line thrown out of use on March 1, and the erection of the new steel work is proceeding with rapidity, and, it is hoped, will be completed and double-line working restored early next month.

The total weight of the cast-iron ribs removed was 408 tons, and the total weight of steel in the new work, including the steel castings in bearing-pins, etc., 608 tons.

NOTES ON THE FOOTBRIDGE, LOCK, AND WEIR, RICHMOND (SURREY).

By J. H. BRIERLEY, Assoc.M.Inst.C.E., Borough Surveyor.

The control and conservation of the river Thames are in the hands of a body of thirty-eight Conservators, usually spoken of as the "Thames Conservancy."

In the year 1889, however, a Bill was lodged in Parliament on behalf of the Richmond Vestry and the Twickenham Local Board, "to authorise the construction of a Footbridge with removable sluices and a Lock and Slipway on the river Thames in the parishes of Richmond and Isleworth and for other purposes," and the Act authorising the scheme was passed in the following session.

The somewhat unusual procedure of two local authorities requesting Parliament to sanction a River Improvement Scheme to be carried out by the conservators of such river was the final outcome of an agitation for some improvement in the condition of the river Thames between Teddington and Isleworth (extending over a period of some thirty years) on the part of the two above-mentioned local authorities, riparian owners, and others interested in its condition.

The level of low water had been gradually falling until in later years at low tide the stream was so shallow as to be insufficient to allow a pleasure steam-boat of the lightest draught to float along it, and its muddy foreshores were both unsightly and offensive.

The state of things complained of was primarily due to two causes, viz. the removal of Old London Bridge in the year 1833, and the ever-increasing quantity of water abstracted from the river above Teddington Lock by the London Water

Companies. Dredging in the lower section of the river, and the greater waterway provided in reconstructing other bridges, had also contributed to the evils complained of in a lesser degree.

Petitions were from time to time presented by the Richmond Vestry and others to the Conservators, pointing out that large sums of money had been received by them from the London Water Companies in return for the privilege of increasing their intake from the river, and that some consideration was due to those who were thereby condemned to endure the evils attendant on the consequent unsatisfactory condition of the Thames below Teddington Weirs, due in some measure to the decreasing volume of water flowing over the weirs there.

In 1871 a further memorial was presented to the Conservators, earnestly entreating the Board to construct a lock and weir, or otherwise relieve the inhabitants of the district from the intolerable nuisance which they had so long and patiently borne, and which, in the absence of a lock, would daily increase.

The Conservators then appointed Sir John Coode and Captain Calver, R.N., to report to them, and also to confer in the matter with Sir James Abernethy, the engineer retained by the Richmond Vestry.

To those who either are now, or may possibly in future be, closely concerned with the question of the present condition and desired improvement of a tidal river, a perusal of the report presented by the two first-named gentlemen, containing as it does the result of certain observations and inquiries into the condition of the river, and their opinion as to the causes responsible therefor, with the conclusions arrived at by them as to the remedy for the evils admitted by the engineers to exist, will doubtless prove interesting.

Shortly, Sir John Coode and Captain Calver deprecated the construction of the suggested lock and weir, which in their opinion would be injurious, as it would cause silting in the river, both above and below the structures; result in the loss of tidal volume from the river where it is of the greatest value; diminish the scourage power, and needlessly interfere with the navigation; and would also tend to increase the frequency and extent of the flooding of adjacent lands.

They recommended the improvement of the river by the entire diversion of sewage therefrom; by dredging; and also by the construction of practically uniform slopes along the foreshores, between the high- and low-water lines throughout the district between Teddington and Kew, so that all the indents and resting-places for silt should be removed.

The engineers, however, expressed their conviction that there was no portion of the whole tidal division of the Thames which stood in greater need of improvement than that lying between Kew Railway Bridge and Teddington Lock.

On the other hand, Sir James Abernethy as strongly advocated the construction of a lock and weir as the best method of procuring an additional depth of water between Richmond Bridge and Teddington, and preventing the deposit of offensive mud on the shores and in the bed of the river.

The Conservators stated in their next annual report that they had come to the conclusion that a judicious deepening of the river by dredging will afford a safe and proper remedy for the existing defects in the navigation, and they have, in consequence, commenced the needful works; but for the next ten years they did nothing beyond a little dredging, and the evil state of things continued.

In 1883 certain local residents lodged a Bill for a new lock and weir at Isleworth; but this, for lack of means, was dropped.

Threatened with an inquiry by a Select Committee of the House of Commons the Conservators at last undertook to execute certain improvements, and spent some 21,000*l.* in dredging and embanking the river between Teddington and Kew Bridge.

These works, which their expert advisers had some fifteen years previously confidently predicted would effect the necessary improvement, proved, however, so far as then carried out, to be quite inadequate.

Further memorials and appeals to the Conservators having proved unavailing, the local authorities, on behalf of the long-suffering residents, at last took the bold step, as previously mentioned, of lodging a Bill in Parliament, providing that the Conservators should execute the works of constructing the new footbridge, lock, and weir, unless within six months after the passing of the Act they should give notice to the Local Authorities (or one of them) that they did not intend to do

so; in which case the local authorities were to be empowered to carry out the works.

The Bill was naturally strenuously opposed in both Houses, but the opposition fortunately proved futile, and the Act authorising the scheme was, as before stated, passed in the session of 1890.

The Act gave the Conservators the option of executing the works, which on completion (certified by the Board of Trade) were to vest in the Conservators, to be thenceforth maintained and worked by them at their own charge, they taking the tolls of the footbridge and lock.

The Act also gave power to the Sanitary Authorities within the riparian parishes to levy a rate not exceeding in any year 2*d.* in the pound. A penny rate now suffices for Richmond Parish.

The rateable value of land, houses, and property, of which any part is within 100 yards of high-water mark (ordinary spring tides), is for the purposes of rates under the Act to be deemed to be twice the value at which the same stands in the valuation list.

The estimated cost of the works was 40,000*l.*, which it was agreed should be divided as follows:—

	£
Richmond	22,945
Twickenham	14,160
Petersham	1,147
Isleworth	1,068
Ham	680
	£40,000

The expenses of obtaining the Act (4500*l.*) were in part paid by subscriptions, and the balance (two-thirds) by the local authorities.

The Conservators decided to execute the work themselves, which, after revising the plans, they did in a most efficient manner, and they also bore the additional cost, amounting to some 21,000*l.*, the total cost of the works thus being 61,000*l.*

Description of Works.

The structure consists of a bridge, having five arches, and carrying a double gangway, 348 feet in length, between the

banks, and 28 feet in width; the two gangways being each 6 feet wide, with a central space of 16 feet between them, which is occupied by the sluices when raised.

The three centre arches, containing the sluices, are of 66 feet span, the two end ones being each of 50 feet span.

Under the arch on the Surrey side is the Lock, which is 250 feet long, and 37 feet wide for two-thirds of its length, the gates being 26 feet wide. Under that on the Middlesex side is a slip-way, with three sets of slides and rollers, for the passage of pleasure boats.

Under the staircase leading to the footbridge on the Surrey shore is arranged a lock-keeper's house, and on the other side workshops, etc., are similarly placed; the buildings being of red brick, with Bath stone dressings.

The abutments and piers of the bridge are of Portland cement concrete, faced with blue Staffordshire bricks and Cornish granite, the foundations being carried down to the London clay.

The elliptical girders carrying the gangways are of steel plate, the web of each being in two pieces only.

The three centre arches are fitted with Stoney's Patent Sluices, each 66 feet wide by 12 feet high, and weighing 32 tons, constructed of steel plates, stiffened on the downstream side by two steel arched girders, and which sluices, at the date of erection, were the largest then constructed.

The sluices are suspended on trunnions at each end, fixed at a point coincident with the centre of gravity, and which slide up and down in vertical guides, recessed into the sides of the piers; under the trunnions at each end are passed two steel wire ropes, 1 inch in diameter, which run over a large pulley attached to the lifting gear above, and to the end of each of the four ropes is fixed a counterbalance weight, weighing 8 tons.

The counterbalance weights work in wells, constructed of steel plates, each 3 feet square, built in the masonry opposite the end of each sluice.

These wells also act as supports to the vertical guides and bearers, which are planed surfaces of cast iron, between which and the ends of the sluices are interposed the free rollers, of which there is a set on either side, arranged to take the pressure of the water, so that the friction is reduced to a minimum.

The sluices weigh 4 tons more in air than in water, and the difference is compensated for by additional special balance weights, carried on differential chains, and perfect balance is thereby at all times maintained; and the sluices can be readily raised by two men by means of the winches placed above on the piers.

An ingenious arrangement, designed to prevent unsightliness, is provided by means of a wrought-iron lever (carrying a small pulley), which projects from one end of the sluice; this when rising meets, and then travels in a curved guide (which is connected to the vertical guide near the top), when the sluice reaches the level of the parapet of the bridge, so that the sluice is then turned over flat on its side between the two gangways, being thus hidden from view by the girders and parapets of the bridge, at the same time allowing a clear headway of 21 feet above Trinity high-water mark.

The rollers which receive the pressure of the water, whether directed up or down stream, are placed in a cradle working in the recess opposite the ends of the sluice, and which is suspended by two ropes fixed to a girder on the bridge; the ropes being passed under the sheaves of the rollers, and over the trunnion bearer, the rollers thus rising with the sluice but at half the speed, having only half the distance to travel.

The lifting gear fixed on the top of each pier is similar at both ends, motion being imparted to the pulleys over which the suspending wire ropes pass by means of a crab winch attached to one set of gear only, the power being conveyed by means of a 5-inch shaft and spur gearing, from one side of the arch to the other.

The sluices, which maintain a maximum pressure of 100 tons each when lowered, are so accurately counterbalanced that they are floated and raised with the rising tide, by means of a timber float fixed on the up-stream side of each about 18 inches below the top.

The object of the sluices is to hold up the water to 5 feet 9 inches below Trinity high-water mark, *i.e.* about half-tide level (ordinary spring tide), the difference between low water and the average height of spring tides being about 11 feet; and they are worked so that the water is so held up between 8 a.m. and 9 p.m., but the Conservators are empowered, by consent of the Board of Trade, to keep up the sluices as they

may consider necessary for the due protection of the navigation of the river.

In practice the sluices are kept up for three or four successive nights twice a month.

In times of heavy rains and floods they are of course always kept up.

When the tide has ebbed to the height of about five feet six inches below Trinity high-water mark the sluices are lowered down to, or to within a few inches of the sills, according to the quantity of water passing over Teddington Weirs.

The water is never allowed to flow over the sluices.

In the daytime a red disc is suspended from the centre of each arch when the sluices are down, and at night a red lamp is shown on the bridge.

The slipway has sloping floors of concrete laid to a gradient of 1 in 8 with 3-inch wrought-iron pipe rollers revolving on bearings 5 feet 3 inch centres fixed to a timber framework.

An iron cradle is fixed at the summit on a rocking spindle at the centre, for passing the boats from one side to the other.

A loan for the several local Authorities' contribution of 40,000*l.* was obtained for a period of forty years.

The foundations and masonry of the Lock, Slipway, and Piers were executed by the Thames Conservancy.

The bridgework and sluices were constructed by Messrs. Ransomes & Rapier, of Ipswich and London, under the direction of Mr. C. J. More, M.Inst.C.E., Chief Engineer to the Conservancy, Mr. Le Neve Foster being Resident Engineer.

The sluices were designed by the late Mr. F. C. M. Stoney, M.Inst.C.E., whose invention has since been as successfully adopted in works of a similar nature on several of the most important rivers in the world.

DISCUSSION.

Mr. G. Midgley Taylor, Westminster: I should like to discuss the question as to the advisability of converting a steam-driven plant into an electrically driven plant. I have had to report to the Glasgow Corporation on the pumping

of their sewage. One of the questions submitted to me was, that having electricity works for tramways and lighting and a large surplus of power, would it not be cheaper to use electricity rather than steam? The Electricity Department undertook to supply the current at $\frac{3}{4}$*d.* per unit, which is even less than the charge at Wimbledon; but on working out, however, the annual expenditure required for pumping with electrical power, and comparing that with the cost of coal, and also taking into account the interest and repayment of capital for thirty years for electrically driven pumps, the annual sum required by the Glasgow Corporation would be something approaching three times more for electricity than for steam. I think it would be extremely interesting if Mr. Cooper could give us some idea of the difference of cost of working these pumps electrically compared with steam. Of course I know if you have an old steam installation—a regular coal eater—the electrically driven plant would be cheaper, but with pumps running regularly, with a charge of $\frac{9}{10}$ths of a penny per unit for current, I do not think an electrical plant can be anything like economical. If there is only intermittent pumping, then it is different; for under those circumstances electricity compares favourably with steam. Particularly is that true if you have only a small plant. At Wilton I have found it much cheaper to run the pumps by electricity and accumulators rather than employ a double shift of men. Again, if you run the plant electrically, it seems a necessity to put in centrifugal pumps. I put in the first electric installation for pumping sewage automatically at Stowmarket. I am sorry to say that the efficiency of that machine in working does not amount to more than 28 per cent., in spite of our having tried several gears and done everything to improve the efficiency. Even at that it is an extremely economical method of working, because it is small and requires practically no attention. But when you come to purchase electrical power at $\frac{9}{10}$ths of a penny per unit and only get 65·7 per cent. of efficiency with the 22-inch pumps and 60·9 per cent. on the 12-inch pumps, then I am of opinion that for permanent pumping steam would be the cheaper. With regard to the centrifugal pumping, Mr. Cooper has explained that he had great difficulty to begin with, because he could not install his screens until after he got the system going. That is a difficulty we have to contend with in pumping sewage

electrically from outlying districts. With electrically driven pumps you must have screens in front of them.

Going now to the bacterial installation, I see that Mr. Cooper tells us he charges his beds twice a day. It would be very interesting to all of us to know the quantity per cubic yard of material applied during that double charging. The information is not in a form to enable us to appreciate the results he has obtained. It would also be of interest if Mr. Cooper could give us the figures of the oxygen absorbed throughout the series. He tells us that the sewage from the first and second beds are analysed, but he only gives us the figures for the raw sewage and the final effluent. I must congratulate Mr. Cooper on the excellent results obtained. I have been over the sewage farm many times, have seen it growing, and have kept in touch with the many alterations which have been made, and it always appears to me that more is being done for purification, acre for acre, than at any other farm in the world. That speaks very highly, not only for Mr. Cooper but for his farm manager.

With regard to Mr. Tomlinson Lee's paper, the cost of *4d.* per thousand gallons for water softening is a very big price. On a larger scale it is possible to soften water for $\frac{1}{4}$*d.* per thousand gallons.

MR. F. R. PHIPPS: The question of pumping, which has been raised by Mr. Midgley Taylor, is one of great interest to municipal engineers. I think we have all had experience that where there is pumping to be done, and there is an electrical undertaking belonging to the Corporation, the Surveyor has been asked to use electrical instead of steam or gas driven pumps. I should like to ask Mr. Cooper if he advised the removal of the steam and gas engines, and the substitution of the electrical pump. I have had very recently to report on the same matter, and I find the cost of the electrical pump is very much in excess of steam or gas. I think the current used for water horse-power per hour with the centrifugal pump must be at least $1\frac{1}{2}$ unit, which at $\frac{9}{10}$ths of a penny per unit for the large 22-inch pump would be for the whole year's running 2847*l.* The cost of steam on the basis of $3\frac{1}{2}$ lbs. of coal at 24*s.* per ton per horse-power hour, not taking into account interest on and repayment of capital, would be 949*l.* I have had experience for the last eighteen months with a suction gas pumping plant, using $1\frac{1}{2}$ lb. of anthracite costing 30*s.* per ton, which is equivalent

to 0·24 of a penny per horse-power hour, or 423*l.* for the year, being about one-sixth of the cost of electrical pumping. If Mr. Cooper could give us the cost, it would be interesting and useful to those who have to advise on the same point. The question of the utilisation of the steam from the destructor for either sewage pumping or other purposes, is one which is much discussed. I see it is mentioned that great difficulty has been found in utilising that steam, though the actual cause of difficulty is not mentioned. My own Council has considered the putting down of a destructor for sewage pumping, which is at present done by coal-fired boilers. The price for street lighting appears to be high as compared with incandescent gas lighting, which would come to about 3*l.* per lamp per annum. I should like to ask if any incandescent gas lamps are in use or whether they are all electrical. Then could we have the number of private motors which are paying 1¾*d* per unit? Considering the large amount of profit made by the electrical undertaking, I should have thought a less price would have been charged for current for power purposes.

MR. A. E. SNAPE: I think it is very satisfactory in the case of the Wimbledon Corporation that they have obtained such good terms from the Tramway Company. It is usually the case that the Corporation has the worst of the bargain. What Mr. Cooper says about the two clauses inserted in the Act, and their successful operation for the Corporation, is of very great interest to the members of the Association. I have noticed the success of the Corporation of Norwich in their appeal with reference to the 18-inch margin on the sides of the tramway track. The Company are held responsible for the paving of that margin, and if that is not done by them they must compensate the Corporation for the money spent in doing it. With reference to the electrically driven plant, it may be of interest to give some particulars of the system adopted in Norwich. Mr. Collins has adopted an electrically driven plant with a vertical spindle, the pump to be drowned. The pump will be worked at night without any attendants in the engine-house and a system of alarm bells will give warning of any mishap. The other two pumps will be belt driven by suction gas engines. We shall then be able to tell the relative efficiency of the electrically driven and the suction gas pumps, as they are both of the same horse-power. I hope when the

system is working we shall have figures of the relative efficiencies of the two types of pumps. I should like to ask Mr. Cooper how the pumps in this system are driven—whether they are driven direct or by bevel gearing. Mr. Collins has found in his investigation that bevel gearing is noisy and inefficient. We are now adopting belt-driven pumps. This has necessitated the pumps being placed at the ground level, and therefore they will not be drowned, but a charging apparatus will be provided. Has Mr. Cooper any difficulty with the stripping of the blades in the centrifugal pumps? In our pumps, which are of the Roturbo type, there is 3 inches clearance between the blades and the casing, allowing material up to an inch in size to pass through without any damage to the pump. We are advised that we shall have no difficulty with the blades. Will Mr. Cooper say what he has done with the pressed sludge? I should have thought it would not be necessary to press the sludge, as by providing a relatively small area of land you could allow it to run into trenches and thereby disintegrate.

The references in Mr. Tomlinson Lee's paper to the Curtis turbine are very interesting. There are not many installations of this American turbine in this country. Would Mr. Tomlinson Lee say what is the output of the turbine, and the pounds of steam used per kilowatt-hour, and thereby give us the efficiency of the turbine?

Mr. S. G. Gamble: Is not the cost of street lighting by electricity, amounting to a rate of *4d.* in the pound, rather high for a town which has no congested street traffic? I notice that the Electricity Department charge a rent of 1*s.* per quarter for meters to small consumers. I presume that includes all the cost in connection with the meter, fixing and keeping in order, etc.

Mr. T. W. A. Hayward: I have always been of opinion myself that, given a constant load, pumping can be done more economically by steam power than by a second-hand power like electricity. The figures given by Mr. Taylor have been most convincing, but I have no doubt Mr. Cooper will give a very satisfactory explanation of why he adopted electrically driven pumps. I think the terms obtained from the Tramway Company are very satisfactory indeed, particularly with regard to sewers. I should like to ask Mr. Cooper if 6 inches of concrete is sufficient for a tramway track? I am rather at a loss

to understand what Mr. Cooper means when he says in one case only has the Corporation seen fit to pave these margins with wood. The paper says immediately before, "The track with the 18-inch margin on either side has been laid with Karri and Jarrah blocks"—I presume at the expense of the Company. I suppose Mr Cooper means the space between the kerb and the 18-inch margin paved by the Company. I should like to know what Mr. Cooper's experience is with regard to macadam roads and wood track for tramways. One of the most difficult things one has to do is to maintain a suitable carriage-way where the tramways run through a macadam road. I have much pleasure in moving a vote of thanks to the authors of the papers.

Mr. Capon: I have very much pleasure in seconding the vote of thanks.

Mr. Liversedge: There are certain references in the paper to bacteria beds. I do not know when the last meeting of the Association was held here, but it is stated that since then five acres of new beds have been added by Mr. Cooper. I should like to ask Mr. Cooper if he is satisfied with a mesh of $\frac{5}{8}$ths of an inch for material in contact beds after the precipitation tank treatment, or whether he has found any clogging of the beds, and whether they have required renewal at any time. I should also like to know what material he uses in the beds.

Mr. Norman Scorgie: I should like to congratulate Mr. Cooper on the arrangement made with the United Tramways Company, and also congratulate Wimbledon that they are not within the area of the Metropolis. If he had had to deal with the London County Council, Mr. Cooper would not have been so successful. I know a case in the north of London where the authority made terms with the Tramway Company to pave the margin of road outside the statutory 18 inches to the kerbstone free of cost to the authority. After a time the central authority purchased the lease, they stepped in and said, "You have made too hard a bargain, and you must contribute 500*l.* towards the cost of this work." In the paper one is given the maximum capacity of the destructor in loads, which are an indefinite quantity. Can we be told what the tonnage is, or even per cubic yard? because we all know that house refuse varies considerably as to its weight per cubic yard.

As to public lighting, I am certainly of opinion that, so far as regards the electrically lighted lamps, the Council are paying

PLATE No. 1.

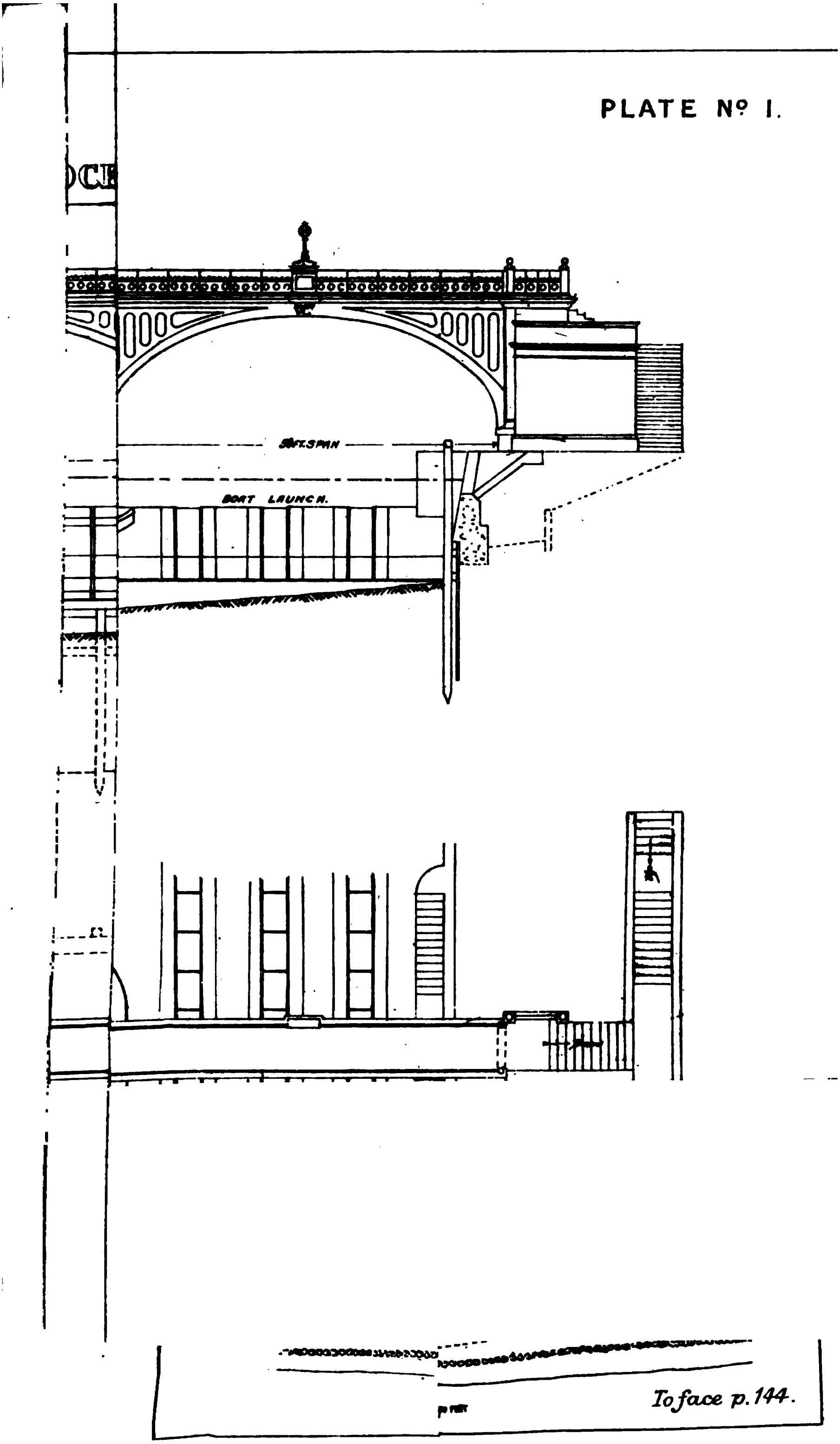

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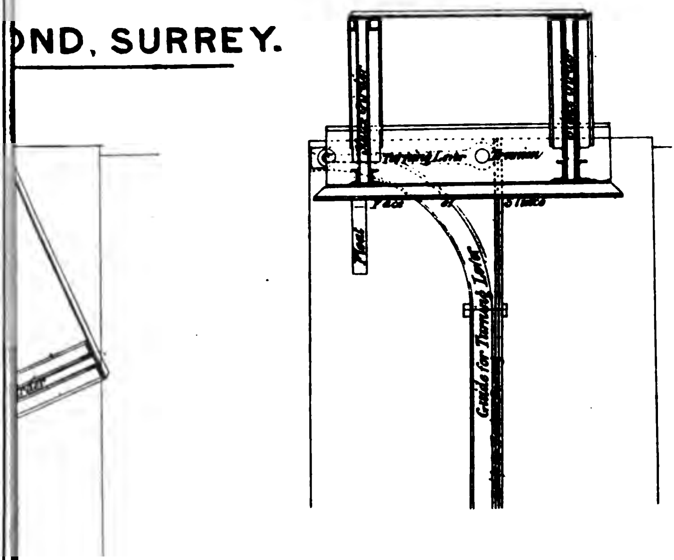
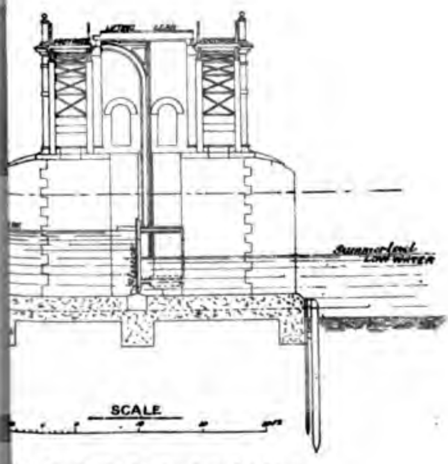
PLATE No. 3.

OND, SURREY.



SLUICE UP



SCALE

ROSS SECTION THRO' SLUICE

To face p. 144.

more than the commercial value for the illuminant they get. It was pointed out by Mr. Phipps that incandescent gas lamps could be lighted, and lighted efficiently, with not less than 50 candles, at something like *3l.* *7s.* *6d.* per lamp. Wimbledon is paying *5l.* 11*s.* 10*d.* When you examine the electric light accounts you can see the reason for this—20 per cent. of the income of the undertaking is paid by the Council. They sell the current to themselves at far more than its value, and if that were not so their accounts would not show the profit they do. I am sorry I cannot congratulate Wimbledon on their electric light undertaking. If you take the amount for reserve fund and relief of rates, and not yet allocated, during the eight years the installation has been at work, it only equals 7½ per cent., or less than 1 per cent. per annum on the capital outlay. It has been stated that at least 1½ per cent. should be put on one side for depreciation and renewals. I know it is being put aside for depreciation, but you want something in addition for renewals, as the loans for machinery have been granted for too long periods. The amount for reserve does not equal ½ per cent. per annum. Would that be the case with a commercial undertaking? I am afraid there would be few companies which would be in a position of solvency for many years if that was the only provision they made. The electric undertaking is working to advantage at the present time, but the time will come when they will require to put their hands in their pockets; and the Local Government Board will not grant loans for renewals of any portion of the plant, the first loans of which are not paid off. And it seems to me, looking at the size of the engines, that several of the smaller sets will be worth little more than scrap iron in a short time.

The Chairman: Time now necessitates the closing of the debate, and I desire to make but very few remarks before asking the authors to reply. The terms obtained from the Tramway Company are abnormally favourable to the Corporation. With regard to the discussion, I think you will agree that it has been interesting and profitable—especially are we indebted to our visitors for their remarks. Mr. Midgley Taylor's remarks are especially valuable, being both scientific and practical. We are unfortunate in not having with us Mr. Szlumper, the author of the paper on the Railway Bridge, and Mr. Brierly, the author of the paper on Richmond Footbridge, Lock and Weir. There are

points in those papers, and especially in the drawings, which will be of great interest to us, and which we shall appreciate more on viewing the works. I shall be particularly interested in noticing the vertical setting of the centrifugal pumps, because there is a difficulty in maintaining the bearings of pumps set in that position.

The vote of thanks was unanimously accorded.

MR. C. H. COOPER, in reply, said: The question of economy in electrically driven pumps *versus* steam-driven pumps has to a great extent been answered by Mr. Midgley Taylor, who found in the case of Wilton and Stowmarket that electricity, even with as low an efficiency as 28 per cent., was the cheaper method of driving. In the case of Glasgow, where, by-the-by, electricity was not tried—only reported upon—steam was considered the cheaper. Glasgow is an instance of raising a large volume of sewage ten times that of Wimbledon, with a comparatively even flow, where the amount of storm water to be raised is only 52 per cent. of the maximum sewage flow, whereas at Wimbledon we allow for pumping storm water equal to eight times the dry-weather flow when one of the large pumps is out of work. The dry-weather flow in the case of Glasgow does not vary more than 33 per cent. from the mean, whereas in the case of Wimbledon the variation would be over 100 per cent. These figures I consider sufficient to show that no comparison should be made between an estimate of the cost of pumping at Glasgow and Wimbledon.

Mr. Phipps has based his figures on a coal consumption of 3½ lbs. per pump horse-power. If Mr. Phipps takes the coal consumption at the L.C.C. station, where large quantities of sewage are raised with much more even flows than can be obtained at Wimbledon, he will find coal consumptions varying from 5·6 to 7·3 lbs. of coal per pump horse-power, which cost from 0·27*d.* to 0·55*d.* for coal alone. To this must be added cost of stoking and interest and repayment on additional capital expended on steam plant. Such a coal consumption could never be got with a much smaller and more variable flow at Wimbledon, where the coal consumption would be at least 10 lbs. per pump horse-power, equal to 1·2*d.* at 20*s.* per ton, whereas electricity at $\frac{9}{10}$*d.* per unit, even with as low efficiency of 50 per cent., would cost only 1·17*d.*, in addition to which the cost of stoking and additional cost of plant is saved.

When the Wimbledon pumping plant was considered, the question of suction and water gas was fully gone into, and the liability of failure to get the additional units to work in time of storm was the great factor which weighed against suction and producer gas, and I may say that a large factory, which has its own gas plant, at Wimbledon would gladly have had electricity at 1*d*. per unit rather than extend their plant, had the Council at the time supplied at that price.

I have not the slightest doubt that the method of raising sewage in the future will be by electrically driven pumps.

As regards the water capacity of our filters, this would, with the later filters constructed, be about one-third, but with those covered with soil would, no doubt, be much less.

With respect to Mr. Snape's remarks, all the pumps I have erected are placed at such a level that they can be charged from the sewers and so worked automatically if desired. There is no gearing or belting connected with the pumps, which revolve on the same shafts as the motors, both revolving at the same speed.

The sludge deposited in the settling tanks is pressed into cake and burnt, as there is no sale for it.

In answer to Mr. Liversedge, I am quite satisfied with our filter beds. What clogging takes place is confined to the first run bed and is removed with the top inch or so of material, which may be said to be renewed once in three years at a cost of about 30*l*. per acre. The filtering material is burnt clay, costing about 2*s*. 4*d*. per cubic yard.

Mr. Hayward has more experience of tramways than I. So far we have found 6 inches of concrete under the track sufficient.

MR. H. TOMLINSON LEE: The first question was raised by Mr. Midgley Taylor, and referred to the cost of water softening. The figure quoted of $\frac{3}{4}$*d*. per 1000 gallons, I think, must be for reagents only. I charge in the item of 4*d*. per 1000 gallons about 1$\frac{3}{4}$*d*. for pumping the water, about $\frac{3}{4}$*d*. for the reagent, and then the cost of repairs and renewals brings up the total to about 4*d*. Mr. Phipps asked how many motors we have on the circuit. Approximately about 40. Of these I do not think there are more than six or seven above 5 horse-power. Mr. Snape asked a question as to the Curtis turbine. The makers guaranteed a steam consumption of 19·7 at full load, 20·4 at three-quarter load, 22·7 at half load, 27·5 at quarter load, the average being

20·9. In view of the tests I have had taken, I can say that we come out so far about 5 per cent. higher.

MR. SNAPE: What is the output of the turbine?

MR. TOMLINSON LEE: One thousand kilowatts. The cost of street lighting was raised by Mr. Gamble, who considers a rate of 4*d*. in the pound as high. If he will refer to the rate in other boroughs, he will find the average is from 5*d*. to 8*d*. Wimbledon is one of the lowest. A question has been asked as to meter charges. Why the meter charges are made on the small consumer is due to this fact. We get an application from a consumer for an installation, and he consumes perhaps three units in the year. We have had to go to the expense of a 10*l*. capital outlay for the installation, and we must have some return on that outlay. If the consumer uses the units, all well and good; but if he does not, then we must have something for it. The charges in Wimbledon are equal, on the average, to any authority around London. With regard to street lighting and the profits of the electricity undertaking, if you refer to our accounts you will see we have a capital outlay of approximately 168,000*l*., of which there is nearly 40,000*l*. for street lighting mains. These mains are not used for any other purpose than street lighting. If you take 40,000*l*. as being the outlay for street lighting, and remember that we only received for street lighting for the year 1907-8 5994*l*. 15*s*., you will see it does not leave us much margin. With reference to the earnings of the electricity undertaking, they work out at 10 per cent. on the capital outlay.

The members had luncheon together at Wandle Park; and visits of inspection were paid to the Foster Arc Lamp Works, the central fire station, the isolation hospital, and to Richmond, where the members were received and welcomed by the Mayor (Councillor T. W. Stephens), and later a visit was made to the Richmond Railway Bridge.

LANCASHIRE AND CHESHIRE DISTRICT MEETING.

May 9, 1908.

Held at the Town Hall, Eccles.

MR. J. LOBLEY, M.INST.C.E., PAST PRESIDENT, *in the Chair.*

THE Members were received by the Mayor (Alderman Nuttall), who offered them a hearty welcome to Eccles.

The Chairman thanked the Mayor for his kind welcome.

Mr. C. Brownridge was unanimously re-elected Honorary Secretary for the Lancashire and Cheshire District.

SOME MUNICIPAL WORKS IN ECCLES.

BY THOMAS S. PICTON,
BOROUGH ENGINEER AND SURVEYOR.

IT is recorded that the village and parish of Eccles derived their names from the ancient church. Eccles is doubtless a short form of "Ecclesia." It can be assumed that the ancient village of Eccles was in existence in the days of the Norman Conquest. Gilbert, son of William de Notten, in the year 1120, gave a grant to the church of Eccles, to the clerks and their men. There is also remaining a quaint old thatched house in Church Street, supposed to have been built in the year 1094.

One of the old Roman roads passed through Eccles. Mr. Charles Roeder says, in his description of "Roman Manchester," "That the road to Coccium (Wigan) was 13 yards wide and issued from the western gate. It was 17 Roman miles long,

and formed the tenth iter. According to Barrett it was a fine paved causeway. In 1832 it was discovered as a broad ridge of gravel and stones on the south side of Regent Road, in the first field on the west side of Ordsall farm. The road to Wigan and the estuaries were probably built by Agricola."

Mr. William Harrison's Archæological Survey of Lancashire shows this Roman road as passing through the north-east part of Ellesmere Park, Chorlton Fold, and Rocky Lane, then through Worsley, Tyldesley, and on to Wigan. The road has been exposed at Worsley and Tyldesley. Pre-Roman coins, canoes, and miscellaneous articles have been found near Eccles and Barton. At Eccles a canoe and also a hollowed log were dug out of the earth during the construction of the Manchester Ship Canal. The old Liverpool and Manchester Railway passes through Eccles; also the famous Bridgewater Canal, which was constructed by the celebrated engineer, Mr. James Brindley, about the year 1754.

During the construction of the Liverpool and Manchester Railway Mr. George Stephenson predicted that in ten years there would not be a single boat on the Bridgewater Canal. That opinion has not proved correct; to-day it is extensively used by the Manchester Ship Canal undertakings; and its utility is generally acknowledged.

A portion of the Barton Aqueduct was removed when the Ship Canal was constructed, but the Corporation decided to retain one of the arches in remembrance of Mr. Brindley's work. This arch has been re-erected near to the original position in Barton Lane.

Mr. James Nasmyth, the inventor of the steam hammer, had his engineering works at Patricroft. The Corporation placing the steam hammer in a prominent position on their coat of arms on account of this invention.

The geological formation of the district consists partly of the new red sandstone, and partly of the coal measures. The regular stratification having generally an alluvial covering consisting of boulder clay, marl, gravel, sand, or the varying mixtures of these. Quick-sands and peat patches are very frequently met with in the borough, to the detriment of builders and contractors. The strata has been subjected to geological disturbance. Although Eccles is not large in area, faults abound; in the course of a mile, four or five faults occur.

Near Monton Green, coal crops up to within six feet of the surface, being overlaid to that depth by boulder clay.

Eccles lies in the Manchester meteorological zone. The numerous wet days in the year, and the similarity of the substratum, subjects both to fogs and mists, those of Eccles being free from the pollutions of the Manchester fogs.

General Statistics.

At the formation of the Local Board, in 1851, the number of houses was 1839; population, 9730; death-rate, 22·64 per 1000. The Charter of Incorporation was granted in May 1892. The borough is divided into six wards. The area, 2008 acres. The population in 1901 was 34,361, now estimated at about 39,000; the number of houses, 7664. Death-rate in 1907, 15 per 1000. Rateable value, 170,000*l.* Poor rate, 3*s.* 4*d.*; district rate, 3*s.* 7*d.* in the 1*l.*; and a 1*d.* per 1*l.* assessment realises 625*l.* Debt, 258,000*l.* The average annual rainfall during the last ten years is 31·345 inches. The consumption of water can be taken at 28 gallons per head per day on the population.

Public Roads.

The total mileage of the public highways in the borough is 25 miles 4 furlongs 53 yards, of which 4 miles 4 furlongs 170 yards are main roads and 5 miles 3 furlongs 177 yards are secondary roads. These particulars do not include 4½ miles which are on the Earl of Ellesmere's estate, and which are considered as private roads, kept in repair by the Earl. These roads are constructed of slag macadam, costing about 1*s.* 6*d.* per square yard.

The county authorities contribute 1455*l.* per annum for the maintenance and scavenging of the main roads, and 425*l.* per annum for the secondary roads, on the understanding that the Council contributes a similar sum. The remaining 15 miles 3 furlongs 146 yards of "other roads" are maintained out of the rates, the average amount during the last five years being 800*l.* per annum.

Thirty years ago many of the public streets were paved with 6-inch grit setts on a foundation of cinders, the joints being filled in with gravel. Owing to the heavy and continuous

traffic that use the highways at the present time the grit sett is not proving a suitable material. The main and secondary roads are paved with 3-inch by 6-inch granite setts, principally from the Welsh quarries. Norway granite setts have been laid down with advantage. Welsh setts, 24*s.* per ton, Norway, 28*s.* per ton, delivered at Eccles.

There are only 3 miles, or about 32,584 square yards, of granite macadam roads in the borough, maintained out of the rates.

Tar Macadam Roads.

The Council has been favourably impressed with the use of tar macadam for certain classes of streets; those which are *cul-de-sacs*, and those which are used by the light vehicular traffic.

Up to the present time twenty-two streets have been laid down with tarred limestone macadam. The first two, being *cul-de-sac* streets, were constructed in August, 1895. They are in good condition at the present time, and have had no money spent on them for repairs. "Stanley Avenue" and "Cavendish Grove" were constructed under contract. The whole thickness of this material when completed is 6 inches, made up of the following gauges: 2½-inch gauge equals 3 inches, 1½-inch equals 2 inches, and ¾-inch equals 1 inch thick. This tarred limestone was laid on a foundation of clinkers, cinders, or brick-bats, 9 inches thick.

The Park.

The cost, including excavation and foundation, was 4*s.* 7½*d.* per square yard. "The Park" was constructed in August, 1897. The cost of this street was 5*s.* 4*d.* per square yard. Three years after it had to be extensively repaired. The total area of the carriageway is 1980 square yards, and the area of the repairs 1238 square yards. The total cost was 142*l.* 16*s.* 6*d.*, or 2*s.* 3½*d.* per square yard. Some repairs were done during 1904–5, amounting to 5*l.* 4*s.* 8*d.* Since construction this road has cost 2¼*d.* per square yard per annum for maintenance. "Paradise Street" was constructed in the summer of 1897, cost 4*s.* 9*d.* per square yard. Four years after, the Northern Quarries Co., Silverdale, were engaged to re-coat the street with 1¼-inch gauge, and on the top ¼-inch and ⅜-inch mixed tarred limestone.

Materials, 88*l.* 6*s.* 3*d.*, labour, 56*l.* 10*s.* 10*d.* Total cost,

144*l.* 17*s.* 1*d.* Area of the carriageway, 1176 square yards. Some repairs were done in 1905 amounting to 2*l.* 19*s.* 5*d.* Since construction this street has cost 3*d.* per square yard per annum for maintenance. "Gleaves Road," constructed during the summer of 1897, cost 4*s.* 10*d.* per square yard. The surface of this road began to break up after four years' wear. The Author tried the following experiment: the surface of the road was hacked and well swept, hot prepared tar well brushed on, and then a coating of $\frac{5}{8}$-inch and $\frac{1}{2}$-inch dry limestone chippings spread on the tar. The steam roller was kept on this road continually until a good solid surface was obtained. Area of the carriageway is 1164 square yards. The cost of the above repairs amounted to 37*l.* 17*s.* 4*d.*, equal to $7\frac{3}{4}$*d.* per square yard. A little repair was done during 1906, amounting to 1*l.* 10*s.* Since construction this road has cost $\frac{3}{4}$*d.* per square yard per annum for maintenance.

Several other tar macadam streets in the borough were constructed by Corporation workmen, the material being prepared in a shed specially erected for the purpose. The work done in this way is proving satisfactory. It is now considered more advantageous to obtain the tarred limestone from a reputed firm, ready prepared for putting on to the street. Also, that instead of a cinder foundation, to put in a foundation of hand-packed broken rubble, 9 inches in thickness, the interstices being filled in with rubble scapplings, and this foundation well steam-rolled before the tarred stone is put on. The cost under this specification works out as follows: Foundation, 1*s.* $5\frac{1}{2}$*d.*, and tarred stone 4*s.* 5*d.* per square yard. After the top coat is finished the street is properly barricaded for over a week, so that the surface can have an opportunity of setting hard before any kind of vehicular traffic uses the carriageway. Insisting upon closing the streets has given excellent results.

FOOTPATHS.

The late Local Board constructed a great number of the footpaths in the district with 15-inch by 4-inch edging, and 12-inch by 8-inch kerbs, forming the footpaths with cinders, paving tiles, etc. These materials are not proving satisfactory, the Council is gradually altering these footways by substituting $2\frac{1}{2}$-inch concrete flags for the tiles, etc. The footpaths to all

... now constructed with 12-inch by 8-inch kerbs, ... concrete flags, on a bed of 4 inches of cinders and ... sand, the flags having a 6-inch bond wherever ... This also applies to all private street improvement ...

Carriageways.

Particulars of Pavements.

The foundation of the paving in the streets mentioned below ... of 9-inch cinders and three inches of gravel, and ... consolidated with a ten-ton steam roller.

6″ Grit Setts.

Name of Street.	Date when completed.	Area of carriage-way in square yards.	Prime cost per square yard, including foundation.	Cost per square yard per annum for repairs.
			s. d.	d.
... Street ...	1897	1986	5 1	0·80
... Street ...	1897	2028	5 2	0·40
... Street ...	1897	2226	5 2	0·10
... Road ...	1898	1800	5 6	0·08
	3″ × 6″ Welsh Granite Setts.			
... Street ...	1898	2576	11 0	—
... Road...	1898	2520	11 0	—
... Road ...	1898	2632	11 0	—
... Road	1898	4392	11 0	—
	3″ × 6″ Norwegian Granite Setts.			
... Street ...	1905–06	370	9 7	—
... Street ...	1905	1260	9 0	—
	6″ Flag Rock Paving.			
... Road ...	1901–05	9720	[illegible]	8¼

Note.—The excessive amount fo... ...eavy motor traffic between Manchester and ...

PARTICULARS OF TAR MACADAM STREETS.

Name of street.	Area of carriage-way in square yards.	Cost per square yard of foundation, including excavation.	Cost per square yard of tar macadam.	Nature of repairs to tar macadam.	Cost per square yard of repairs.	Cost of street per square yard per annum.
		s. d.	s. d.		s. d.	d.
Cavendish Grove	833	0 10½	3 9	—	—	—
Gleaves Road	1164	1 0	3 10	Surface hacked up and coated with ¼" and ⅜" chippings and treated with hot tar	0 7¾	0·74
Mayfield Road	1158	1 6¾	4 7	—	—	—
Paradise Street	1212	0 9	4 0	Recoated with 1¼" tarred limestone ¼" and ⅜" limestone chippings	2 6	3
Richmond Grove	765	1 4	4 3	—	—	—
Stanley Avenue	521	(excav. only) 0 4	4 0	—	—	—
The Park	2058	1 3	4 1	Recoated with 1¼" tarred limestone ¼" and ⅜" limestone chippings	2 3¼	2¼d.

new streets are now constructed with 12-inch by 8-inch kerbs, and 2½-inch concrete flags, on a bed of 4 inches of cinders and 2 inches of sand, the flags having a 6-inch bond wherever possible. This also applies to all private street improvement works.

CARRIAGEWAYS.

Particulars of Pavements.

The foundation of the paving in the streets mentioned below is composed of 9-inch cinders and three inches of gravel, and properly consolidated with a ten-ton steam roller.

Name of street.	Date when completed.	Area of carriage-way in square yards.	Prime cost per square yard, including foundation.	Cost per square yard per annum for repairs.
		6″ GRIT SETTS.		
			s. d.	d.
Cannon Street ...	1897	1986	5 1	0·80
Green Street ...	1897	2028	5 2	0·40
Oxford Street ...	1897	2226	5 2	0·10
Pleasant Road ...	1898	1800	5 6	0·08
		3″ × 6″ WELSH GRANITE SETTS.		
Albert Street ...	1898	2576	11 0	—
Clarendon Road...	1898	2520	11 0	—
Monton Road ...	1898	2632	11 0	—
Wellington Road	1898	4392	11 0	—
		3″ × 6″ NORWEGIAN GRANITE SETTS.		
Church Street ...	1905–06	370	9 7	—
Peel Street ...	1905	1260	9 0	—
		6″ FLAG ROCK PAVING.		
Liverpool Road ...	1901–05	9720	6 6	8½

NOTE.—The excessive amount for repairs per annum is due to the heavy motor traffic between Manchester and Liverpool.

PARTICULARS OF TAR MACADAM STREETS.

Name of street.	Area of carriage-way in square yards.	Cost per square yard of foundation, including excavation.	Cost per square yard of tar macadam.	Nature of repairs to tar macadam.	Cost per square yard of repairs.	Cost of street per square yard per annum.
		s. d.	s. d.		s. d.	d.
Cavendish Grove	833	0 10$\frac{1}{2}$	3 9	—	—	—
Gleaves Road	1164	1 0	3 10	Surface hacked up and coated with $\frac{1}{2}$" and $\frac{3}{8}$" chippings and treated with hot tar	0 7$\frac{3}{4}$	0·74
Mayfield Road	1158	1 6$\frac{3}{4}$	4 7	—	—	—
Paradise Street	1212	0 9	4 0	Recoated with 1$\frac{1}{4}$" tarred limestone $\frac{1}{4}$" and $\frac{3}{8}$" limestone chippings	2 6	3
Richmond Grove	765	1 4	4 3	—	—	—
Stanley Avenue	521	(excav. only) 0 4	4 0	—	—	—
The Park	2058	1 3	4 1	Recoated with 1$\frac{1}{4}$" tarred limestone $\frac{1}{2}$" and $\frac{3}{8}$" limestone chippings	2 3$\frac{1}{2}$	2$\frac{1}{2}$d.

FOOTWAYS.

Particulars of Concrete and Natural Flags.

The foundation of the footways consists of 4 inches of cinders, and 2 inches screened gravel.

The concrete flags are 2½ inches in thickness, and the natural flags 3 inches in thickness.

CONCRETE FLAGS.

Name of street.	Date when completed.	Area of footway in square yards.	Prime cost per square yard, including foundation.	Cost per square yard per annum for repairs.
			s. *d.*	*d.*
Boardman Street	1895	751	4 6	0·3
Cawdor Street ...	1902–07	1768	5 5	—
Clarendon Road	1906	394	4 3	—
Wellington Road	1900	459	4 6	—
		NATURAL FLAGS.		
Alexandra Road	1897	804	5 3	—
Cannon Street ...	1897	904	5 4	0·02
Oxford Street ...	1896	1099	5 1	—
Pleasant Road ...	1898	843	5 9	—

TRAMWAYS.

The Corporation own the electric tramways in the borough. The late Board in 1877 constructed tramways for horse traction, costing 17,961*l.* These lines were leased to the Manchester Carriage Co. In 1901 the Council obtained Parliamentary powers to reconstruct the tramways for electric traction. By agreement, these lines have been leased to the Salford Corporation for a term of thirty-five years at an annual rental of 10 per cent. on the total cost, the Eccles Corporation undertaking the maintenance. The tramways cost 69,647*l.* There are 2 miles 7 furlongs 6·33 chains of double track, and 2 miles 1 furlong 3·20 chains of single track. The gauge is 4 feet 8½ inches. The steel rails are in 60-feet lengths, 7 inches by 7 inches, weight 102 lbs. per yard, laid on a bed of concrete

6 inches thick. Fish-plates, weight 73½ lbs. per pair, each 27 inches long. Sole plate, weight 43½ lbs., 8 inches by ¾ inch by 27 inches long. Tie-bars, section 2 inches by ½ inch, notched at one end and screwed at the other, ⅞ inch diameter, and 4¾ inches long, with two nuts and two washers to each. The maximum gradient is 1 in 20, and the sharpest curve is 50 feet radius. The feeder cables are drawn in Doulton's conduits, and for the return system the rails are bonded with two No. 0000 Chicago bonds. The trolley wires are double throughout the entire system, and made of hard drawn copper, 0·4 inch in diameter. The poles are set 6 feet in the ground, and the base surrounded with 12 inches of concrete. A portion of the system was opened for traffic on October 4, 1902, and the last section on June 1, 1905. The maintenance of the permanent way and the overhead equipment up to date has cost 1497*l*. 16*s*. 10*d*.

The construction of the tramways necessitated many important street widenings and improvements, costing 21,480*l*. These included a new lattice girder bridge and approach roads at Monton Green, in lieu of a very dangerous stone bridge, spanning the canal at right angles. . .

. . . .

SCAVENGING.

In 1893 the scavenging department employed eight men, and hired daily two horses and carts. The area of the roads at that time was: Main roads, 65,026 square yards; secondary roads, 57,947 square yards; and other roads, 55,455 square yards; annual cost, 450*l*. The cleansing and scavenging departments and the town's yard depôt are under the management of Mr. C. W. Laskey, Chief Sanitary Inspector, who has supplied the following information as to the cost of cleansing the highways during 1907: Eighty-one loads of sand were used on the streets, 2621 loads of water used, 17,060 gullies cleansed, 1023 manhole dirt-boxes cleansed, 1623 cart loads and 1658 hand-cart loads of refuse removed. The cost being, for manual labour, 768*l*. 12*s*. 5*d*.; team labour, 578*l*. 12*s*. 5*d*. The area of the roads at the present time is, main roads, 74,196 square yards; secondary roads, 79,183 square yards; and other roads, 226,027 square yards. There are ten men

employed in this department. Foreman's wages, 32*s.* per week; sweepers, 24*s.* per week; all overtime work is paid for. The men get six days' holiday per annum. They are provided with overcoats every alternate year, and with trousers, hats, and leggings annually.

THE TOWN DEPÔT.

In 1893–4 the Council considered the advisability of providing a depôt and their own horses, carts, and other materials for the better working of the several departments, it being found that the hiring of team labour was very unsatisfactory. A suitable site was purchased, containing 6470 square yards of land. Mr. A. C. Turley, then Borough Surveyor, prepared the necessary plans and estimate, as follows:—

	£
Excavating and draining	500
Stabling for twenty horses	1100
Mason's shed and mess-room	120
Men's latrines	100
Cement-stores	150
Smithy and shoeing-forge	230
Provender-stores	700
Large cartshed	440
Foreman's cottage	600
Weighing-machine office	70
Entrance gates	40
Flagging, paving, and kerbing	800
Water and gas mains	270
Machinery	500
Contingencies	50
Total ...	£5670

This scheme was completed in the early part of 1898, at a total cost of 5660*l.* The depôt is situated off Liverpool Road, a little distance beyond Patricroft Bridge. At the entrance to the yard is placed a public weighing machine and office. All goods entering or leaving the yard are here weighed and recorded. Near the entrance there is a vacant piece of land, on which is erected a temporary fire station. Close to the fire station is the horse-keeper's house, and on the opposite side is the men's mess-room and mason's shed. Along the south side of the yard are placed stables for twenty horses, two loose boxes, harness-room, and horse-cloth drying-room. On the

west side is placed the engine-room, provender-mixing room, a shed for carts belonging to the highways department, and also for the storage of materials. Above these are the provender-stores and the machinery for chopping and crushing the fodder. On the north side is a large cartshed, used by the cleansing and scavenging departments, and on the east side are the smithy, wheelwright's shop, cement and other stores. At present the wheelwright's shop and smithy are not used for the purpose for which they were erected, owing to the fact that the annual cost of repairs to implements, tools, etc., does not warrant the permanent employ of men for these trades. Latrines for the men are provided. The store-yard is principally used for the deposit of setts, cinders, gravel, and macadam, etc., used by the highways department. Three departments use the yard—the cleansing, highways, and watch committees. The two latter contribute 50*l.* and 40*l.* per annum respectively for the use of the yard. The highways committee hire team labour from the cleansing committee, the rate being 10*s.* 6*d.* per day for horse and driver. The working of the depôt has proved very successful. Eighteen horses are owned by the committee. These are depreciated year by year; they now represent an average value of 26*l.* 14*s.* per horse.

Provender account for half-year ending March 31, 1907 :—

	s.	*d.*		£	*s.*	*d.*
Oats, 489 bushels, average	2	11¼	per bushel	71	18	4
Bran, 1385 scores, "	1	1¼	per score	76	6	1
Clover, 2678 stones, "		6⅛	per stone	68	17	1
Straw, 1554 stones "		3⅜	per stone	21	17	0
Linseed			... ...	1	6	6
Beans			... ...		18	0
Indian corn			... ...		12	0
Sundries			... ...	5	6	0
			Total ...	£247	1	0

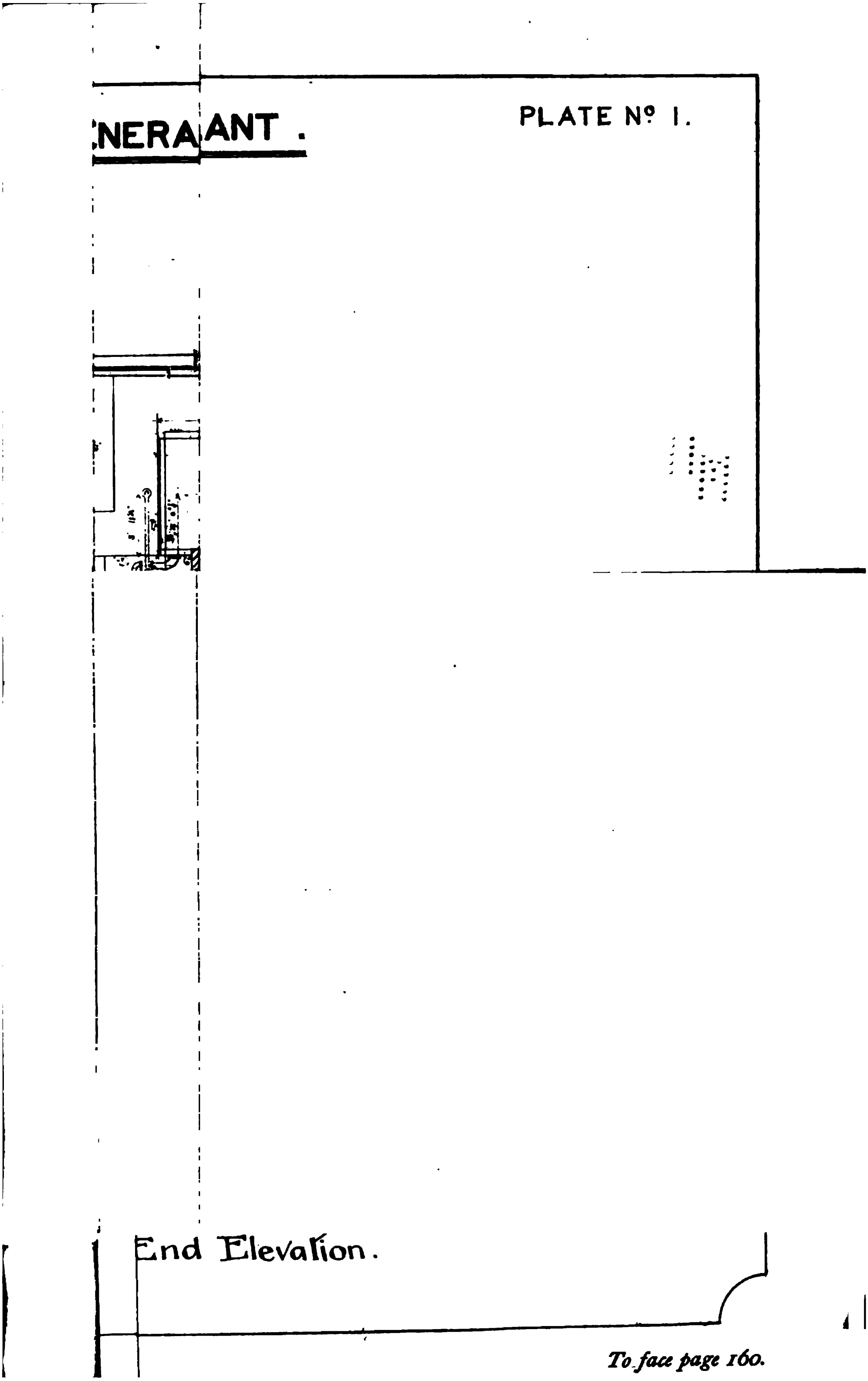
Four hundred and twenty-two weeks' keep of horses average 11*s.* 8½*d.* per horse per week.

Wages of workmen: Horsekeeper, 35*s.* per week, with house, coal, and light; carters, cleansing department, 27*s.* per week; scavenging department, 27*s.* per week; highways department, 26*s.* per week. Cleansing department, foreman, 29*s.* per week; ash-pit men, 27*s.* per week; ash-bin men, 26*s.* per week. In 1903 the Corporation erected, adjoining the town

depôt buildings, a public mortuary, 16 feet 3 inches long by 13 feet wide and 12 feet 6 inches high, containing two mortuary tables, at a cost of 222*l.* 8*s.* 9*d.*

SEWERS.

In 1851 the drainage arrangements of the district were so defective that Robert Rawlinson, Esq., held a Government inquiry on the subject, and he recommended the formation of the Local Board for the purposes of the Public Health Act, 1848. From 1851 to 1874 the district was properly drained. The necessary plans and sections included a 4-feet by 4-feet main outfall brick sewer and several 3-feet circular brick sewers; making junctions with these trunk sewers are conduits 24 inches, 18 inches, 15 inches, 12 inches, and 9 inches in diameter. The sewer in Rocky Lane is the greatest in depth, being 51 feet below the surface. There are about 43 miles of public sewers in the borough. During the last eight years the Author has used, with great success, 12-inch, 9-inch, and 6-inch ramp junctions, when constructing shallow sewers, having their outlets into deep sewers. Soon after incorporation Mr. Arthur C. Turley, A.M.I.C.E. (now City Surveyor, Canterbury), reported strongly upon the advisability of the Corporation dealing effectively with storm water. Many complaints of flooding in the low-lying parts of the borough were brought before the notice of the Committee. The volume of water coming down to the lower districts, during heavy rainfall, was more than the sewers could discharge; as well as putting extra work on the pump engines at the Sewage Farm. In 1896 Mr. Turley prepared several schemes dealing with this question; eventually sanction was obtained for all the proposed works to be carried out. In 1897 a 3-feet by 2-feet sewer was constructed in Liverpool Road. It is 746 yards in length and an average depth of 16 feet 3 inches. It has nine manholes built on it for inspection purposes. It was constructed throughout in tunnel. The invert is formed with Doulton's stoneware invert blocks, sides of sewer are constructed with Staffordshire blue bricks. Arch of sewer with a 4½-inch ring of pressed radiated engineering bricks, backed with 4½-inch cement concrete. At the summit an overflow weir has been fixed, which is so arranged



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that when the 18-inch shallow main sewer from Eccles is flowing more than two-thirds full, the excess can pass over the weir into the new 3-feet by 2-feet sewer. This arrangement will prevent the backing-up of sewage taking place in flood times up the branch drains connected with the 18-inch pipe sewer above mentioned. This new sewer cost 2015*l.* 0*s.* 9*d.* The following are the full particulars of the storm-water scheme. A 3-feet by 2-feet intercepting sewer constructed along the south side of the borough in close proximity to the Manchester Ship Canal, having its outlet into the 3-feet circular sewer in Barton Lane. It is 1768 yards in length, the greatest depth being 24 feet; 740 lineal yards was tunnelled through hard red sandstone rock. There are 27 manholes and lampholes for ventilation and inspection purposes. The construction of this sewer was as follows: Doulton's stoneware invert blocks, 4½-inch blue bricks lining up to the springing of the arch, backed with 4½ inches of cement concrete. The remainder of the sewer being 4½-inch stock radiating brickwork in the tunnel portion, and 9-inch brickwork in two rings for that which was constructed in open cutting. All brickwork was set in cement mortar. This intercepting sewer is connected to the storm overflow conduit which discharges its waters into the Ship Canal. The total cost was 3941*l.* 0*s.* 10*d.* A duplicate 3-feet 3-inch circular sewer in Liverpool Road from New Lane to Tindall Street is 377 yards in length, of an average depth of 19 feet. This new sewer was necessary by reason of two 3-feet 3-inch circular sewers joining at the junction of New Lane with Liverpool Road. The sewer in New Lane was disconnected and continued to the street above named. This sewer was constructed with 9-inch stock radiating brickwork in two rings, set in cement mortar, for the top half of the sewer, and one ring of radiating blue bricks for the bottom half, laid on a bed of cement concrete, 4 feet 9 inches by 2 feet 6 inches. Four ordinary manholes and lampholes have been built, but two special manholes were built on this sewer. The first chamber being 29 feet 6 inches long by 9 feet 2 inches wide and 11 feet 6 inches high from the invert, inside measurements. The walls are 14 inches in thickness, the inside being faced with stock engineering bricks and backed with common. The benching is composed of cement concrete, 6 to 1, 3 feet 6 inches thick. The roof is arched over with three rings of

stock radiated brickwork, set in cement mortar. The second special manhole opposite Tindall Street is 17 feet long by 15 feet 3 inches wide and 10 feet high from the invert, inside measurement, the materials for the construction of this manhole described as above. The roof of this chamber is constructed with 6-inch stone landings resting on 9-inch by 7-inch and 4-inch by 3-inch rolled steel joists. In this chamber is fixed an overflow sill, 11 feet 9 inches by 1 foot 2 inches by 9 inches at the proper level connected with the 4-feet by 3-feet storm-water overflow, which discharges into Salt Eye Brook. The cost of this sewer was 2121*l.* 6*s.* 3*d.* A 4-feet by 3-feet storm-water overflow is constructed from the 3-feet 3-inch circular sewer near the manhole opposite Tindall Street, to discharge into the brook above mentioned. This overflow is 447 yards in length and constructed as follows: 4½-inch blue brick inverts and sides, with 9-inch stock radiated brickwork on the top, set in cement mortar and encased in cement concrete. Two manholes are built on this overflow for ventilation and inspection purposes. It cost 1778*l.* 19*s.* 4*d.* A 4-feet by 2-feet 9-inch storm-water overflow is constructed from the 3-feet 3-inch circular sewer in Barton Lane opposite Fountain Street, to discharge into the Manchester Ship Canal. The materials of construction similar to overflow in Tindall Street. It is 180 yards in length, and has four manholes built on it. This overflow cost 578*l.* 15*s.* 8*d.* There are also two small overflows in Peel Green Road. A 9-inch pipe receiving surface water and a 5-feet by 1-foot culvert from Peel Green Road sewer. They discharge into the Manchester Ship Canal, and cost 300*l.* The whole of these storm-water overflows were completed in 1898. Since that date we have had many heavy thunderstorms, frequently registering 1½ inch to 2 inches of rainfall within the twenty-four hours.

The Author desires to state that Mr. Turley's scheme has proved entirely successful, for in the districts that were previously affected no complaints whatever have been received as to cellar flooding.

The Sewage Farm.

The scheme prepared was to treat the sewage by precipitation in tanks and subsequently purification upon specially

prepared land. The quality of the land purchased was suitable for filtration purposes, being principally sand and gravel. It was also well situated and the configuration of the land generally favourable, though the pumping of the sewage daily would be an absolute necessity.

In 1893 the dry-weather flow of sewage was 925,000 gallons. The price for 40 acres of land was 6000*l.*, the remaining area at a chief rent of 10*l.* per annum per acre. The Corporation established Farm Buildings upon their works, to effect a more economical management, for by providing them they would be able to keep their own horses for working upon the farm, and cows for dairy purposes.

On the completion of the works in 1895, Mr. G. W. Willis was appointed Sewage Farm Manager, and he has kindly supplied the Author with the following information.

Description of the Works.

The catch pit is 20 feet long by 8 feet wide, having an inclined floor, and is provided with a screen fixed the full width, having taper bars ½ inch apart. The screen is cleansed by means of scrapers of two rows of steel teeth, riveted to cross bars and fitted between the bars of the screen.

The pump well is 25 feet long and 20 feet wide, and is provided with sump to ensure the suction and delivery of sewage containing any matter which can pass through the screen. The pump well and catch pit are covered in with a concrete roof; but manholes are provided. The sewage is raised into the discharging basin, through 20-inch pipes from the well. The basin is 12 feet in diameter, and contains the bell-mouth, 6 feet in diameter. This is fitted to the delivery pipes into which the sewage is forced, and gently overflows its sides. The conduits to the detritus tanks are 3 feet wide, and are coterminous in length with those tanks. They are provided with openings at uniform distances. Penstocks are also fixed admitting sewage into the tanks as desired. The detritus tanks are in duplicate, each 30 feet by 30 feet, 6 feet deep at the top side and 8 feet at the lower side. Each tank has an equal number of cast-iron trapped outlets. The settling tanks are five in number, two, 120 feet by 60 feet, two, 135 feet by 60 feet, and one,

135 feet by 22 feet. All fed from a conduit 4 feet wide. Each settling tank is divided into three parts by means of cross walls and sills for preventing the flowing of solid matters in the sewage. Each tank is 7 feet deep at the sides, and 8 feet in the centre. The distributing troughs are 2 feet 6 inches wide, designed with special openings which enables the flowing of sewage to be uniform. The settling tanks can be worked either on the intermittent or continuous flow system. By the latter method it is possible to irrigate any plot of land on the farm, and when necessary to sludge the tanks they can be worked on the intermittent flow system. Their total capacity is 1,500,000 gallons. Cement concrete has been used in the construction of the foundations, floors, etc., of the tanks, well, etc. The floors floated and finished smooth, the walls faced with blue bricks set in cement mortar, coping, granite concrete. The carriers consist of glazed stoneware socketed pipes, from 18 inches to 24 inches diameter, having joints made with caulked gaskin and cement. The distributing chambers are 35 in number. Each chamber is 3 feet 9 inches square, and is constructed with a concrete floor and foundation, brick walls and granite concrete coping. The effluent passes through a short length of iron pipe and falls into the main grip made in the land. The farm is divided into 28 plots. The highest being 16 feet above the lowest. They vary from ½ to 4½ acres in extent, and are so arranged that any class of crops can be cultivated. The land is drained with seconds earthenware pipes, laid from 3 feet 6 inches to 5 feet in depth, at fixed distances apart, according to the quality of the sub-soil. They are laid in herring-bone manner, and so arranged that the tank effluent cannot pass into them before it has flowed on to and through the land. Aerating shafts of 6-inch vertical pipes are provided to each plot. The farm is laid out chiefly for intermittent downward filtration with broad irrigation; succulent crops, such as Italian rye grass, cabbage, and mangold wurzel, are grown with much success. The nature of the sewage is domestic with trade refuse, which is about 20 to 25 per cent. manufacturers', bleachers' and dyers' refuse waters, the quantity per day being about 400,000 gallons. In most cases it is treated first on the manufacturers' premises. During 1907 the dry-weather flow of sewage amounted to 1,500,000 gallons per day. The sludge deposited in the tanks flows into pipes which convey it to be discharged by gravitation

to the sludge beds; these are formed of porous materials, 2 feet 6 inches in depth, coarse cinders and clinkers at the bottom and fine cinders at the top. The outfall sewer below the catch pit is now utilised as a storm overflow. A sill being constructed in it and to come into operation when the sewage is beyond eight times the ordinary flow. Storm-water filters are being constructed 3 feet in depth, main discharge pipes 18 inches to 12 inches in diameter, subsidiary drains, 6 inches to 4 inches, laid 8 feet apart. The filtering media, coarse clinker from the destructors, constructed as streaming filters, capacity 500 gallons per square yard per day. The area of the contact filter beds when completed will be 14,500 square yards, capacity 50 gallons per square yard. The beds are filled three times daily and equal to dealing with 2,175,000 gallons per day. The contact beds average 3 feet in depth, with main discharge pipes 12 inches to 9 inches diameter, subsidiary drains, 4 inch diameter, 8 feet apart, the walls, etc., are constructed of concrete. Filtering media is crushed and graded clinkers. Clinkers passing over 1½-inch ring mesh is laid to a depth of 18 inches, graded upwards to clinker passing ½-inch ring mesh and rejected by ¼-inch mesh.

Buildings and Machinery.

The buildings are of a substantial and simple character, and consist of a manager's house, and machinery buildings, the latter consist of destructors, boiler-house, engine and pump house, tool-house, chimney, etc. The chimney is octagonal in shape and 90 feet high. The walls are faced with buff bricks. The farm buildings consist of stabling for 6 horses, cowsheds for 36 head of cattle, loose box, cartsheds, food stores, and milk-house. The machinery consists of 2 destructors, boilers, pumps, clinker-crushing plant, etc. Two boilers of the Lancashire type, each 28 feet long and 7 feet diameter, 135 lbs. pressure, heating surface 817·02 square feet. Three engines, 4 pumps, dynamos, etc., are provided. Two of the engines are of the horizontal pattern, high pressure, 25 I.H.P., and 1 inverted engine 95 B.H.P., 2 crank compound condensing enclosed type with forced lubrication. The pumps are of the centrifugal type—two 9-inch and two 10-inch. Each 9-inch pump will raise 90,000 gallons

of sewage 26 feet high in one hour, and the 10-inch pump 120,000 gallons. The dynamo, 7 K.W. capacity, is direct driven by single crank inverted engine.

Refuse Destructor.

The refuse destructor is a "Simplex" twin cell type. Each unit is equal to a 30-ton disposal of ordinary refuse every 24 hours with a 10 per cent. margin. The residue is a hard vitreous clinker about 33 per cent. of the total quantity of refuse destroyed. The evaporation in the boilers is equal to 1·33 lbs. of water, per pound of refuse destroyed, the water passing into the boilers at 212 degrees Fahrenheit. The destructors, which commenced firing operations April 1, 1904, are worked continuously, destroying practically the whole of the refuse of the borough. The steam required to drive the pumping engines and other machinery is evaporated by the refuse. The average quantity of refuse burnt per week of seven working days is 210 tons. The annual costs in connection with the destructor, furnacemen, and flue cleaning, 520*l.* The repair and maintenance of the furnaces last year was 16*l.* 0*s.* 10*d.* For tools, etc., 25*l.* per annum. Capital charges, etc., 308*l.* per annum. The income is a saving in coal of 810*l.* per annum. Annual income for the sale of clinker for bacteria beds, 262*l.* Bye-products, 5*l.* per annum.

Clinker Crushing Plant.

This plant consists of clinker mill with a capacity of 4 tons per hour, elevator, revolving screen, shoots, mortar mill, etc., driven by vertical inverted engine fixed in engine-room. The crushing and delivery of the clinkers to the bacteria beds costs about 10*d.* per ton.

Cost of Sewage Works.

Pump well, catch pit, detritus and settling tanks, conduits, carriers, contact beds, storm-water filter, and the draining, forming and levelling the land, buildings for boilers, engines, pumps, etc., boilers, engines, pumps, and other machinery,

boundary wall and gates, farm buildings, consisting of cowsheds, stables, barn and cartshed, weigh-house and machine, 27,436*l.*

Building for destructors, inclined roadway, destructors, clinker-crushing plant, mortar mill, etc., 4473*l.*

Building for disinfector, disinfector machine, bedding removal van, etc., 606*l.*

The annual charge upon the rates, interest and sinking fund, is 2090*l.*, or a rate of 3·55*d.* The annual charge for working expenses of destructors, pumping station, farm operations, and rent is 2228*l.*, or a rate of 3·86*d.* Total, 7·4*d.*

Gas, Water, and Electricity.

The gas is supplied by the Salford Corporation, who laid down the first 8-inch main in 1854, along Gilda Brook Road, Church Street, Liverpool Road to Patricroft. Price at that time 5*s.* per 1000 cubic feet. At the present time it is 2*s.* 10*d.* per 1000 cubic feet.

The water is supplied by the Manchester Corporation, from their reservoir at Gorton. They commenced this supply in 1862 by means of a 7-inch trunk main. The diameter of the distributing mains is 3 inches, 4 inches, and 5 inches.

The electricity station in Cawdor Street is under the management of Mr. H. W. Angus, electrical engineer. The station was first erected in 1898, but since that date additions have been added. The system is single-phase, alternate current at 2000 volts, 200 volts at consumer's terminals. Electricity for working the tramways in the borough is generated at this station. The total cost when fully equipped will be 40,037*l.*

Workmen's Dwellings.

In 1896 the Corporation commenced a scheme for demolishing nearly 140 insanitary houses, in close proximity to the Town Hall. The purchase of these properties cost 22,649*l.* Most of the old houses have been pulled down. A new street and sewer have been constructed, and some new buildings erected on the site. To house the people displaced from the

above, the Corporation erected 46 workmen's dwellings in Lewis Street, Patricroft, costing 12,750*l.*, including price of land. Particulars of cost as follows :—

	£	*s.*	*d.*
Contract and extras	10,586	18	9
Grates	332	8	9
Wall-papers	42	10	1
Ashbins	14	1	0
Electric installation	151	18	5
Half cost of boundary wall	10	16	2
Cost of street works	845	4	5
Sewering and man-holes	261	12	7
Architect and quantity surveyor	410	8	2
Clerk of works	50	0	0
Miscellaneous	3	19	1
Total	12,709	17	5

The chief rent on the land amounts to 60*l.* 18*s.* per annum.

	ft.	ins.		ft.	ins.
Parlour...	13	9	×	11	0
Living room	13	9	×	11	2
Scullery	7	6	×	6	7
W.C.	5	0	×	3	0
Front bedroom	13	9	×	11	0
Second bedroom	11	6	×	6	8
Third bedroom	9	6	×	6	8
Bath room	5	9	×	5	8

All rooms are 9 feet 6 inches in the clear, and there is about 200 square feet of garden provided for each house. The cubical contents being 11,666 cubic feet. Each house has cost 276*l.* 6*s.*, which works out at about 5·6842*d.* per cube foot.

The class of tenants comprises railway servants, engine-drivers, and skilled artisans, joiners, paper-hangers, etc.

The houses are let at the weekly rentals of 7*s.* and 6*s.* 6*d.*

Town Hall and Public Library.

The present Town Hall was built in 1878, at a cost of 6826*l.* This building was extended in 1898, with new council chamber, committee rooms, police court, etc. This cost 7485*l.*

Mr. Andrew Carnegie presented to the borough a handsome Free Library, costing 8700*l.*, of which sum he has already given 7500*l.*

FIRE BRIGADE.

The Corporation has a Voluntary Fire Brigade, with a temporary fire station at the town depôt. The staff consists of four permanent men and eleven retained men, under the superintendence of Mr. William Woodhead. The appliances consist of a steam fire-engine and a chemical engine and escape combined, and a horse ambulance. There are eight fire alarm boxes, placed in different parts of the borough. The Corporation hope, at some future date, to house the brigade in an up-to-date fire station.

CEMETERY, RECREATION GROUNDS, AND BATHS.

The Corporation possess a cemetery of 36 acres, costing 11,908*l.* to lay out. Also three recreation grounds, 10, 10, and 12 acres respectively, and other open spaces. There is a public swimming bath at Patricroft, erected in 1882; but it requires enlarging on more modern lines. It cost 4833*l.*, including extensions.

DISCUSSION.

MR. A. J. PRICE: The first thing I have to speak about is the tar macadam. The prices are, no doubt, the best you can get in this district, because you have had the work done by contractors in competition; but they seem high in comparison with the price for which I am able to get the work done at Lytham. I see Mr. Picton has been able to carry out a good deal of work himself. He says, "it is now considered more advantageous to obtain the tarred limestone from a reputed firm, ready prepared for putting on to the street." I should like to know the reason for this. The experience my Council has had with contractors doing tar-asphalting has convinced them that I can do the work at Lytham as well as any outside firm. I should like to know why you are using Norwegian granite setts instead of Welsh setts. It is stated that the Norwegian setts at 28*s.* a ton, work out at 9*s.* and 9*s.* 7*d.* per square yard; therefore I cannot understand how it happens that the streets paved with Welsh

setts of the same size at 24*s.* per ton, work out at 11*s.* per square yard. As to the sewage farm, the scheme seems to have been prepared originally for precipitation, and I should like to know whether you still adopt chemical precipitation, or whether you have done away with chemicals, and adopted the bacteria system. That is to say, have you converted your settling tanks into open sceptic tanks, and done away with the expense of chemicals, and also the cost of dealing with the sludge.

MR. H. G. WHYATT: I have lately used a good deal of tar macadam, but I am not yet able to compare the average price. Mr. Picton says the first streets made in Eccles in 1895, both *culs-de-sac*, were made 6 inches thick of tar macadam. It seems rather extravagant; 6 inches is too thick for a *cul-de-sac*. I notice the cost is given as 5*s.* per square yard; but, on turning to the tabulation, it appears as being 4*s.* 7½*d.* The cost of the street known as the Park is given as 2¼*d.* per square yard, per annum for maintenance, but in the tabulation it is given as 1·8*d.* I think the answer to Mr. Price's question, as to the difference in cost between Norwegian and Welsh granite setts is that the Norwegian setts are somewhat lighter in weight per cube foot, and therefore they spread over a larger area: another reason is that the Norwegian setts are not so well dressed as the Welsh, and lie farther apart. The Welsh setts are very accurately dressed, and lie closer together. As to the Tramways, I think the Eccles Corporation made an excellent bargain with the Salford Corporation in getting 10 per cent. on the cost of the lines, making a revenue of 7000*l.* per annum on four miles of road. I wish something had been said in the paper as to what becomes of the 7000*l.* Of course some of it has to be used to meet the payment of interest and instalments of loan, and in five years the cost of repairs has been 1500*l.* or 300*l.* a year. Are the Eccles Corporation putting the balance to the credit of the district fund, and relieving the rates, or saving some of the money to meet the cost of the big repairs when they come in future years? (The Mayor: Saving it.) If so, what have you added to the district fund, and saved the rates in consequence? Another thing which strikes me is the horse food. The daily rations are 7 lbs. of oats, and 9½ lbs. of bran a day. It seems to me almost criminal to feed horses with 9½lbs. of bran a day. From what I am told by horse experts it is practically the same as if you were to take a spoonful of Gregory's

powder with every meal you eat. It is a purgative. If the oats were doubled and the bran divided by three, the cost of horse keep would be less, and the horses would manage a little bit better. The food we give our horses is—16 lbs. of oats, 2 lbs. of beans, 3 pounds of bran, making 21 lbs. of corn food. We give the horses as much hay as they like to eat. The total cost of our 20 horses for one year was 506*l.* 19*s.* 9*d.*, which comes out at 9*s.* 9*d.* per horse per week, against the Eccles cost of 11*s.* 8½*d.*, that is a difference of 2*s.* per week on each horse, a saving of that much is well worth consideration. I can corroborate the paper that Mr. Turley's scheme was entirely successful, and that there were no further complaints of cellar flooding. I think the date we noticed the floods ceased was 1897. The only other point was with regard to the sewage farm. Mr. Picton says they bought 40 acres of land for 6000*l.*, and the remaining area is rented at a chief rent of 10*l.* per acre per annum. The area rented is not stated. I congratulate the borough upon the progress it has made.

MR. G. W. LACEY: I will propose a vote of thanks to Mr. Picton for his excellent paper. I should like to know the consumption of water, for trade purposes. With regard to tar macadam roads, 6 inches of tar macadam on a good foundation seems an extravagant depth unless the traffic is particularly heavy, which in the streets mentioned does not appear to be the case. Perhaps Mr. Picton will give us some information as to what kind of traffic the roads have to bear, as, unless the traffic is heavy, one would think there was something wrong with the material, or the method of putting it down, seeing that they have gone into a state of disrepair in three or four years. No other material but limestone appears to have been put down. With regard to new streets, the estimated cost of making up the streets, not including sewers, would be useful information to have in the paper. With regard to teams, it appears to me that the Cleansing Committee in hiring out teams at 10*s.* 6*d.* per day are getting a very good price. With regard to horse keep, I am of opinion that too much bran is given the horses, but if Mr. Whyatt can feed his horses at 9*s.* 6*d.* per week he is doing it more cheaply than most of us. I think the cost at Eccles is fairly reasonable. I cannot do it for 11*s.* 8*d.* even, for the last few years. There are a few points with regard to the sewage farm. I should like

to know how the sludge is disposed of. With regard to the contact beds that are being made, Mr. Picton gives the area as 14,500 square yards, with a capacity of 50 gallons per square yard with three fillings, making a total quantity capable of being dealt with of 2,175,000 gallons per day. That is 1½ times the dry weather flow only, and he will have to work his beds at a higher rate than that stated to deal with three volumes. I do not see how he is going to do it, without some choking in future. The storm-water overflow sill, he states, is set for eight times the ordinary flow, and if that large volume is to be dealt with, where is the water going? With regard to the refuse destructor, Eccles is in a fortunate position. On the face of it, a rate of nearly 7½*d.* for sewage disposal would seem to be a comparatively heavy rate, but looking at the amount a penny rate produces, the assessment in Eccles would not appear to be unduly high. The accommodation provided in the workmen's dwellings is not mentioned in the paper, but according to the diagram displayed there is a parlour, living room, and scullery, and three bedrooms. Mr. Picton might state the difference in the houses let at 7*s.* and 6*s.* 6*d.* There is not much difference in the rental, and I take it there cannot be much difference in the accommodation.

MR. A. LAWRENCE COX: I have much pleasure in seconding the vote of thanks to Mr. Picton. I was much surprised to find, on reading the paper, that Mr. Picton had not tried any granite tar macadam, but that all his work had been in limestone. Limestone of the ordinary class is of such an exceedingly porous nature that it cannot possibly wear as well as granite. A standardised asphaltic mixture should be adopted that would adhere firmly to the stone and also withstand climatic effects. Another important feature is the grading of the broken aggregate. Under ordinary conditions the interstices in the road crust is about 40 per cent., and this is one of the weak spots of the present system, in the water bound road this space is filled with dust or mud as the case may be, and in tar bound roads is an element of weakness owing to the liability to retain an excessive amount of tar.

MR. J. S. BRODIE: I have laid down tar macadam in limestone granite and blast furnace slag, and I must say, in my experience, limestone gives the best results. Other people may

have arrived at different conclusions to myself, but, in my experience, limestone has given the most uniform results, both in regard to the appearance of the road and its subsequent maintenance. I have looked with care at the prices set forth by Mr. Picton, and I think they are very reasonable indeed. I cannot touch Mr. Picton's figures as regards the cost of upkeep of my sixty horses, and I am sure my Stable Committee are animated with extreme feelings of economy. Therefore I take it that Mr. Picton's figures are not extravagant. I have some parts of our Blackpool Corporation tramway system which are leased to two companies, one at the north end and one at the southern end of the town. In the case of one company we have an arrangement whereby we receive a percentage on the capital outlay, and we have to keep up the maintenance of the line, and in the other case we have a smaller percentage, and the company has to pay for the upkeep of the lines. I need not assure you that there is no comparison between the two methods. The upkeep is much heavier than any tramway man thought it would be, and I advise you to put the cost of maintenance on to the shoulders of the company, and not on to the corporation. It seems that the usual percentage is nine or ten per cent. on the outlay, the corporation undertaking the maintenance. This will land the corporation in a deficit on their tramway undertaking at no very distant date. As regards tar macadam, some of us may find some day—whether we mix our aggregate ourselves, or get it from people who mix it for us—that the tar wants not to be halfway down or at the bottom, but as near the top as possible. An experiment which is being made at Liverpool by the city engineer, our present esteemed president, of putting down the dry macadam, and afterwards spraying the tar on the top of it, gives promise of much success. I have laid down tar macadam both departmentally and by contract. I must say that the work by contract has been quite as satisfactory as that done departmentally.

Mr. Shillington: Nothing has been said in the course of the discussion about the effect of putting tar macadam on a road with a steep gradient.

Mr. W. Welburn: The paper only gives us the total cost of the destruction of the refuse. Can Mr. Picton give us the cost per ton? [Mr. G. W. Willis, farm manager: It is 10·99*d.*

per ton.] I should also like the cost per million gallons of dealing with the sewage at the works. The paper in this case gives the dry weather flow and not the total flow.

Mr. J. S. SINCLAIR: With reference to the tar macadam roads. The foundation of these roads is stated to be 9 inches of clinkers, cinders, or brickbats. This question of foundation is simply a matter of the natural formation of the geological strata. I find at Widnes, where we have a clay foundation, 9 inches deep is not sufficient, and where road foundations are made with cinders they have turned out very unsatisfactory. My experience is that the heavy traffic crushes the cinders down to a fine grit; the foundations made up of boiler cinders 1 inch to $\frac{5}{8}$ of an inch diameter, when taken up four or five years later, were found crushed to small particles. If the subsoil is sand you may have a 9-inch deep foundation with a suitable hard material, but with clay or a heavy marl subsoil 9 inches is insufficient to stand the swelling during times of frost and the expansion of high summer temperatures. I notice that Mr. Picton has not done any tar-spraying. I should fancy that on some of his side and *cul-de-sac* streets, if he tried tar-spraying on granite macadam it would be more economical than tar macadam roads, and would allow him to put in a good foundation to start with. I have done about a mile in length of these tar-sprayed roads, and some parts have been for two years used with light vehicular traffic, and show very little sign of surface wear; this has been done at a cost of 1*d.* per yard super., and includes cost of tar, chippings, and a certain amount of sand. As regards the cost of horse-feeding, I think it is very low. At Widnes I cannot do it at the present time for less than 12*s.* 6*d.* per week. It varies with the price of provender, and has been as low as 10*s.* 10*d.* The weight of food we give to our horses per day is as follows: Beans, 2·5 lbs.; Indian corn, 2·5 lbs.; oats, 4·01 lbs.; bran, 5·1 lbs.; linseed, 0·8 lbs.; meal, 0·15 lbs.; rack hay, 14·3 lbs.; total (say), 29 lbs. per horse. With regard to the rate of 10*s.* 6*d.* per day for horse hire, I think the Committee are charging a high price for this work, but it may be accounted for in expensive plant, and for the repayment of capital charges. The cost in Widnes of horse hire, including repayment of capital charges, cart repairs, renewals, etc., is 9*s.* to 9*s.* 6*d.* per day.

MR. WHYATT: Might I explain that I am in a very fortunate

position for buying provender. We pay from 18*s*. to 20*s*. per quarter for oats, and this works out at 23*s*. 8*d*. We get bran at 5*l*. per ton, and this works out at 6*l*. 3*s*. 8*d*. We buy direct from the threshing machine, and we get an advantage that way.

MR. BRODIE: Don't you underfeed the horses?

MR. WHYATT: With 21 lbs. of real food a day? No, I think not.

THE CHAIRMAN: In my district we have to be very cautious with the use of tar macadam. The education of our horses is very backward. They are so used to gradients of 1 in 8 that even with a gradient of 1 in 50 they do not like tar macadam. I think the Eccles Corporation is to be congratulated on the very low cost of the sewage works. We are just completing works costing 100,000*l*., so I am rather envious of the way in which Eccles has got out of its difficulty. As to the workmen's dwellings, I should like to know if they are self-contained houses, and not let in flats. They will not have flats at all in my district. Those who go in for workmen's dwellings want a sort of a garden city, so at present we have not got any workmen's dwellings at the cost of the rates. There are plenty of new houses in Hanley at very much lower rentals than these. Each house standing on its own ground, fronts on a 12 yards street, and private back yards in accordance with the model bye-laws.

The members were entertained by the Mayor and Corporation to luncheon in the Town Hall.

In the afternoon the members visited the Carnegie Library, the Monton Bridge and approaches, the town depôts, the Electricity Station, and the Barton Aqueduct and swing bridge on the Manchester Ship Canal. At the Barton Bridge, Mr. W. H. Hunter, Chief Engineer to the Canal Co., was present and the bridge was swung for the inspection of the company.

COMMUNICATED REPLY.

MR. T. S. PICTON in reply: To execute a number of tar macadam streets, the Committee in 1899 erected a temporary shed for drying, heating, and preparing the tar macadam.

When those streets were completed, it was considered advisable to wait for a few years to see how they turned out under the traffic, before going on with any more tar macadam carriageways. The shed was removed to one of the yards and used as a store shed. Six years elapsed before any more streets were approved as tar macadam streets; and after careful inquiries and examination, the Committee then adopted the policy of accepting tenders for the tarred limestone, ready prepared. As far as I can judge at present, the material obtained in this way is giving every satisfaction and proves just as economical to us, as preparing it by our own staff of men. The Norwegian setts were used on the highways where the gradients were steep, and the reason why I used them, although 4*s.* per ton dearer than the Welsh setts, was that this particular class of Norway granite is of a non-slippery nature. I have had them paved on a gradient of 1 in 20 five years ago, and they are giving every satisfaction. Since the opening of the Sewage Farm in 1895, no chemical precipitation has been used by the Sewage Farm Manager in the working of the farm. The cost in the tabular statement in connection with "Cavendish Grove," 4*s.* 7½*d.* is correct, the 5*s.* is an error. The cost of maintenance in "the Park" is 2¼*d.* per square yard, the item in the table is an error. The calculation has been taken over the whole area of 2058 square yards, instead of on 1238 square yards, the area repaired. The extra cost of paving the Welsh setts is on account of the higher price of materials in 1898 as compared with 1905–6.

The rent from the tramways, after the costs of maintenance have been deducted, is set aside as a "reserve fund." The area of the sewage farm rented is 31¼ acres. As Eccles obtain their water supply from the Manchester Corporation, they do not make it a practice in their arrangements with any of the outlying districts to keep the amount of water used for trade and domestic purposes separate.

When the Committee first commenced laying down tar macadam, they were advised 6 inches in thickness was not too much. I agree, for I do not think you can get a satisfactory conglomerate of tarred stone less than 6 inches. Then, again, in my opinion, 6 inches acts as a better cushion for the traffic. The experience of those who have put down a number of tar macadam roads is that you cannot tell how the street will turn

out. If the stone is not dry, and the mixture not properly prepared, the work cannot turn out well; and when it is executed by different contractors, you may, perhaps, have the danger of the streets breaking up. The foundation to all new streets is formed with 9 inches of hand-packed rubble, blinded with cinders, and steam-rolled. (When tarred macadam is to be used, the interstices of the rubble are filled up with broken stones.) Five-inch flag rock setts or 6-inch grit setts, or tarred macadam is used for the carriageway; 12-inch by 8-inch kerbs, and the footways flagged with 2½-inch concrete flags. Without sewering this costs about 17*s.* per foot of frontage. The sludge at the Sewage Farm is run on to filter beds, then carted on to the land, and ploughed in. The revenue from the Sewage Farm is deducted before arriving at the cost of the rates. The houses let at 7*s.* per week are in the front street, those let at 6*s.* 6*d.* per week are in a side street and near to a street of inferior property. There is no difference in the construction of the dwellings. Some of the tar-macadam streets in Eccles have been laid down on gradients of 1 in 22, 1 in 22·43, and 1 in 23·3. I have not received any complaints as to their slipperiness. All the tar-macadam streets were constructed under the 150th section of the Public Health Act, 1875, for the forming of private streets. Therefore, in this case, tar-spraying would not be suitable. I have done a considerable amount of tar-spraying on the ordinary macadam roads, and find it very serviceable. The whole of the workmen's dwellings in Lewis Street, etc., are self-contained.

EASTERN COUNTIES DISTRICT MEETING.

May 30, 1908.

Held at Norwich.

C. H. COOPER, M.INST.C.E., MEMBER OF COUNCIL, *in the chair.*

The Mayor (G. E. Buxton, Esq.) received the members and offered them a hearty welcome to Norwich.

Mr. W. Weaver, Past President, thanked the Mayor for his kind welcome.

Mr. J. W. Cockrill was unanimously re-elected Hon. Secretary for the Eastern District.

SPECIAL FEATURES OF THE SEWAGE PUMPING MACHINERY, REINFORCED CONCRETE RISING MAIN, AND TRAVIS SYSTEM SEWAGE TANKS, IN PROGRESS AT NORWICH.

BY ARTHUR E. COLLINS, M.INST.C.E., (PAST PRESIDENT),
CITY ENGINEER, NORWICH.

NOTE.—The present meeting at Norwich has been arranged to enable Members to see certain works in progress of a novel character. The new engines and pumps are in course of construction at the builder's works, but no parts thereof are yet on the ground.

The "Bonna" reinforced concrete pipes and the Travis sewage tanks are in interesting stages of construction. It is hoped to show the works in operation at a future meeting.

Existing Sewage Outfall Pumping Plant.—The existing Sewage Outfall Pumping Station at Trowse, Norwich, was designed and carried out in 1868 by a former President of the Association, the late Mr. A. W. Morant, then City Engineer of Norwich.

The engines, three in number, are jet condensing beam engines, each with a steam cylinder 36 inches by 72 inches, and driving a bucket and plunger high-lift pump and a bucket low-lift pump. The former pumps sewage a total lift, including suction and delivery, of 132 feet to the top of Whitlingham Sewage Farm through 1¾ mile of 20-inch cast-iron pipes. The low-lift pump is not used, the valves being removed, the bucket remains attached to the engine as a balance weight only. The low-lift pumps when used delivered direct to the River Yare.

These engines are very wasteful of fuel and will in future be used as reserves.

Existing Sewage Screen.—The sewage is screened through flat bars spaced 1 inch apart. The screen is inclined and fitted with the now usual raking gear, which the writer first designed and applied at Salford in 1882.

In the paper read by the present writer at the District Meeting held in Norwich on June 10, 1898, he stated that the sewage from the low-lying parts of Norwich below the levels commanded by the then recently constructed outfall sewer was raised by Shone ejectors. These at that time had scarcely been completed. The ten years' constant use of these ejectors since 1898 has shown that absolute reliance can be placed upon them. The cost of repairs has been trifling, and the renewals have been of the slightest character. They, together with the air-compressing machinery, were built by Hughes & Lancaster of Ruabon.

Sewage Outfall new Pumping Machinery

The new pumping machinery at the Trowse outfall will consist of four "Roturbo" pumps constructed by Parkers, Limited, Wolverhampton, on Rees' patent.

One pump will be at the bottom of a vertical spindle having a 150 B.H.P. electric motor at the top.

The pump will be fixed at such a level as to be self-charging, but it will stand in a dry chamber. The suction side will be connected with the sump by a 14-inch suction pipe fitted with a sluice valve.

The delivery side will have a sluice and a retaining valve, both of somewhat special character.

The motor circuit will be closed and opened by switch gear arranged in five steps, and operated by a float rising and falling with the sewage in the sewage sump, from which all the "Roturbo" pumps will draw.

The electrically driven pump is arranged to start and stop automatically, it being for night work, and when in use an attendant need not be present. In the event of the sewage flow becoming abnormal and beyond the capacity of this unit, the continued rising of the float closes circuits operating alarm bells in the dwellings (close at hand) of the attendants, who will start one or more of the other units hereafter described.

The electric motor and equipments are being built by Messrs. Laurence & Scott of Norwich, and the installation includes Scott's patent switch gear, which is especially adapted for automatic working with big currents. The current will be continuous at 440 volts and obtained from the Corporation's mains.

The other three pumps will be similar to that above described, excepting that horizontal spindles will be provided; they will be fixed 11 feet 6 inches above suction level and will not be self-charging, this not being necessary, as they will be driven by gas engines requiring the presence of an attendant for starting and stopping, who can charge the pumps when required by means of an electrically operated Roturbo air exhauster.

As before stated, four pumps will be provided, each of a capacity of 2800 gallons per minute, at a maximum total head (including friction) of 117 feet, and to deal with a variation of head from 117 feet to 94 feet, at the lower heads the volume of water to be increased inversely as the head.

The guaranteed efficiencies of the pumps are 70 per cent. at the normal rated duty. This is a conservative rating, and the efficiency under actual conditions is expected to be higher than this.

The special feature of the Roturbo pump is that the power does not vary appreciably over the whole range of the variation in head.

This self-regulation is the unique feature of the Rees-Roturbo pump over an ordinary centrifugal or turbine pump, and the great advantage is accomplished by departing from the ordinary design of a centrifugal. The patentee informs me that instead of designing the impeller to impart speed energy to the water equivalent to the head required, the impeller is replaced by what may be described as a revolving pressure drum of very large capacity in comparison with the orifices at the rim. The consequence of this design is that the water enters the pressure drum and becomes practically stationary with reference to the revolving drum, being carried round by vanes or partitions in this drum. As a consequence of this a pressure is generated at the rim of the pressure drum about 10 per cent. greater than the maximum lift that the pump is designed for. A series of directed nozzles or turbine blades are arranged at the rim of the drum, which convert a portion of the pressure in the drum into velocity, and if these nozzles are directed rearwardly, the pressure inside the drum is then available for turbine effect, which increases with increased volumes of water flowing through the drum. The result of this turbine effect is to transfer the power which would otherwise be absorbed from the motor to the rim of the impeller. As a consequence of this, the power taken by the motor never exceeds that required for the normal duty of the pump, and on the lower heads the power taken by the motor actually decreases. The effect of this may be illustrated by the accompanying curve, Fig. 1, in which the approximate shape of the power curve of an ordinary centrifugal or turbine pump is given, and plotted on the same scale is the power curve of a Roturbo pump. It will be noticed that the two power curves from maximum head and no flow of water up to normal head and flow of water are approximately the same, the only difference being that due to the turbine effect. It appears to be possible, without any special care being taken in the designing, to secure somewhat better efficiencies than with the ordinary turbine pump for the same head and duty when running at the same speed, but the power curves beyond the normal point, as the head falls and the flow of water increases, will be noticed to

vary very largely, and it is over this range of the duty of the pump that the Rees-Roturbo shows its characteristic features, and which consequently gives it a great advantage over the ordinary pump where fixed to any duty where the head dealt with is a variable quantity.

Curves are given on Figs. 2, 2A and 2B of three sample pumps of varying duties, each about 70 to 80 feet maximum, the normal duties being 60,000 gallons per hour, 30,000 gallons per hour, and 12,000 gallons per hour respectively, from which the wide range of head within high efficiency limits will be noticed.

The estimated curves of the pumps for Norwich are given in Fig. 4.

An incidental advantage of the design of the Roturbo is the reduction of wear and the consequent permanence of the efficiency attained. The ordinary centrifugal or turbine pump, depending upon speed energy between the impeller and the fixed casing, necessarily is subject to great wear when the water is charged with sand or grit.

Taking actual figures, a lift of 100 feet on a centrifugal pump requires a velocity of water at the tips of the impeller of approximately 80 feet a second. In the case of the Roturbo, the rim of the impeller for a similar duty would also revolve at a speed of 80 feet a second, but having already secured the pressure inside the revolving drum, it becomes possible to throw the water back almost tangentially, at a speed of, say, 40 to 50 feet a second, consequently the resultant speed of the water in the fixed casing is only about 35 feet a second (Fig. 3).

As a result of this, and also because the pressure drum cannot have any cavitation troubles to reduce the efficiency, the cutwaters or expanding channels may be removed some considerable distance from the rim of the impeller, and the pump will, when dealing with large quantities of water, give high efficiencies with a free vortex. As a result of this there is nothing in the path of the water after leaving the impeller to wear away, and when the water is expanded in a free vortex to the points of the tips of the deflecting vanes in the fixed casing, the speed of the water is so slow that results have demonstrated there to be no tendency to wear at this point. As there are no impediments to the flow of anything that has passed the

impeller, there is consequently no possibility of any damage to the Norwich pumps due to pieces of solid matter up to an inch in diameter being carried up with the sewage.

The smallest orifice in the rim of the revolving pressure drum in the case of the Norwich pumps is 1⅛ inch diameter, and as the space between the revolving rim and the deflecting vanes in the fixed casing is approximately 2 inches, anything which will pass through the pressure chamber has got a clear flow through the fixed casing without any possibility of breakage or damage to the pump.

The passage through any pump is always, of course, in proportion to the duty, and the larger the pump, necessarily the larger the particle which can be carried through.

In the case of the Norwich pumps, the sewage will be screened so that nothing exceeding ⅞ inch diameter will pass up the suction pipe.

Fig. 5 shows an arrangement of the vertical pump and motor.

Fig. 6 gives the horizontal type of the pump, showing the pressure chamber removed and the deflecting vanes or cutwaters in the fixed casing.

Fig. 7 gives detail of the bearing and stuffing box therefor.

To avoid risk of excessive wear and tear of the pump journals and their bearings by extrusion of gritty water, the writer has designed special lantern brasses to be inserted with the journal gland packings. These lantern brasses form water chambers around the journals, and are supplied with clean water at a higher pressure than that in the pump, with the result that any gland leakage will be of clean water into the pump and not of gritty water out of it.

The contract price for the four Roturbo pumps fixed complete, but not including foundations, pipe work, and buildings, is 1424*l.* That of the electric motor, including special switch gear and alarm bells in attendants' dwellings, is 450*l.*

Each of the three horizontal spindle Roturbo pumps will be belt-driven by a 175 B.H.P. horizontal two-cylinder Tangye gas-engine, supplied with suction gas by a Tangye producer. The engines are of most massive design; they will receive a similar quality of firing mixture at each cycle, the governors regulating the quantity of mixture. In addition to all usual

water-cooling of the engines, the pistons and the suction valves will be water-cooled. The arrangement of the engines and producers is such that one cylinder of each engine can conveniently and economically be used alone when a small amount of power only is required. The ignition will be by magneto. The ignition plugs will be arranged to permit of cleaning the firing-points whilst at work. The engine beds are arranged to catch all oil, so preventing soakage into the concrete engine loadings. The cylinder lubrication is by positive pressure, the amount being visible. The cost of each gas engine with its producer, erected complete, but exclusive of foundations and builder's work, is about 1560*l.*

This includes for an air-compressing engine for starting, circulating pumps, and other necessary items.

New Sewage Screens and Detritus Pits.

The existing sewage screen will be removed and specially designed screens substituted therefor in the existing pit. The new screens will consist of steel plates $\frac{5}{16}$ inch thick, perforated with closely pitched circular holes of $\frac{7}{8}$ inch diameter, prepared by Poole's patent perforating machinery at Hayle, Cornwall. The plates will be supported in angle-iron frames, which also support a large rectangular bottom box forming a detritus pit. The frame, with its sewage screen and detritus pit, is mounted on guide wheels running in vertical wall guides in such a manner as to be raised to above the surface of the ground by means of a 10-ton electric hoist, and when so raised the screen and pit collections can be removed through an end door into a waggon standing at a lower level.

The screens and silt pits will be in duplicate; the flow of sewage will be shut off from a screen before it is raised for cleaning.

A hose and water under pressure will be used for cleaning the screen. This arrangement was adopted to avoid the great cost of sinking a large screening chamber in very bad soil, and to avoid the trouble arising in the use of screens and raking gear of the present pattern. The estimated cost of the screens and silt pits, including electric hoist, is 420*l.*

The arrangement of screens is shown in Figs. 8 and 9.

NEW REINFORCED CONCRETE RISING MAIN.

The sewage pumped will be conveyed to the tanks in course of construction at Whitlingham Sewage Farm through a 36-inch rising main $2\frac{1}{2}$ miles long, constructed of reinforced concrete on the "Bonna" system by the Columbian Fireproofing Co., Ltd., of 37, King William Street, E.C. This construction was advised after prolonged inquiry and inspections of existing works, some of which had been in use fifteen years and were apparently in perfect condition.

The working head at Norwich is 125 feet, to which must be added for shocks arising from pulsation and periodic waves of pressure in such a length and size of pipe.

The elements of the pipe are:

(1) A cage of light + section steel wire wound into a spiral; the spiral is held in pitch by longitudinal wires tied to the spiral at each alternate intersection.

(2) A tube of thin sheet steel of the whole length of pipe closely fitting outside (1).

The jointing of the steel tube sheets is effected by means of oxyhydrogen blow-pipes, which make autogenous welds. In most of the autogenous welding at Norwich it has been found convenient to use ordinary lighting gas instead of pure hydrogen. For heavy welding, oxyhydrogen or oxyacetylene are preferred because of the greater heat.

The oxygen and the acetylene, or other heating gas, may be so regulated at the blow-pipe as to give either a fusing flame or a burning or oxydising flame. With this latter flame iron or steel can be cut to any shape; with the former, it can be fused or welded together with no waste.

(3) A cage of heavy + section steel wire wound into a spiral, the pitch being dependent on the internal pressure to be resisted. This spiral is also held in pitch by longitudinal wires bound to the spiral at each alternate intersection. The longitudinals also provide the tension elements for resisting transverse bending. (3) closely fits outside (2).

(4) An internal lining of cement mortar or fine concrete keyed to interior of sheet steel tube by the internal spiral cage.

(5) An external lining of cement mortar or fine concrete keyed to the exterior of sheet steel tube by the external spiral cage.

(6) A primary joint consisting of bitumen, this remaining watertight notwithstanding slight flexure.

(7) A secondary and structural joint consisting of a short length of heavy + section spiral covering the joint, surrounded and encased when *in situ* with cement, mortar, or fine concrete.

The interior and exterior cement mortar or concrete coatings are applied as follows:—

(*a*) A collapsible iron mould slightly longer and, when extended, of the interior diameter of pipe is placed on end.

(*b*) The assemblage (1), (2), (3) is placed concentrically around (*a*).

(*c*) An iron cope or mould in three sections longitudinally, and having an interior diameter similar to that of outside of finished pipe, is placed concentrically around (*a*) (*b*).

(*d*) Cement mortar or fine concrete is poured into the concentric spaces each side of (2), which are partly occupied by (1) and (3), the cope or mould being struck with heavy mallets to assist consolidation and extrusion of air.

In warm weather the moulds may be removed in three hours; in cold weather in one or more days.

The pipes are left standing on end till the concrete is quite hardened, generally about five weeks, when they are laid flat for finishing and are then ready to be laid.

When the writer was considering the scheme now in progress he obtained prices for cast-iron, steel, and "Bonna" reinforced concrete pipes, these latter being on the only system known to him likely to meet his requirements. The result was that the "Bonna" pipes were offered laid and jointed complete in Corporation trenches at about three-quarters of the price of steel, and somewhat more than one-half the cost of cast iron.

The Local Government Board have sanctioned a fifteen years' repayment period loan for these pipes, at the same time allowing a thirty years' period for ordinary concrete in sewage tanks.

The rising main will cross the River Yare by an inverted syphon.

The usual air valves will be provided where necessary, also a valve for emptying the rising main into the outfall sewer.

A relief or safety valve (Fig. 10) of large size and special

design will be placed on the rising main at Trowse. It will be a double beat valve, and, notwithstanding its discharge area being equal to 452 square inches, which at the blowing-off pressure of 56 lbs. to the square inch amounts to over 11 tons on that area, the actual weight of the valve and its super load will only amount to 12¼ cwts.

The valve will open freely when the designed internal pressure is exceeded, but is controlled in closing by an adjustable cataract gear.

The writer's object in designing this special valve was to ensure effectual interference with periodic waves or fluctuations of pressure in such a long large main, which are often most destructive, causing pressures in some cases greatly exceeding those of ordinary work.

Travis System Hydrolytic Sewage Tanks and the Principles and Practice of their Operation.

The greatest departure from ordinary practice arises in connection with the sewage tanks.

The Norwich Sewage Farm was laid out for broad-cast irrigation by crude sewage in 1868, and gave sufficiently good results till a few years since, when the substitution of an average of 3,000,000 gallons of strong sewage per day for 6,000,000 gallons of subsoil water containing sewage soon showed the Farm to be insufficient for the desired purpose.

As the result of many visits to sewage works in various parts of the country, of several inspections, and an investigation of the work accomplished by the hydrolytic and other tanks, the writer was forced, against his prejudices, to the conclusion that the Hampton experiments and treatment proved that the general practice of tank treatment of sewage was based on error, and he decided to recommend the adoption of the Travis system of hydrolytic tank treatment for Norwich.

Tanks are now being constructed to the writer's designs, prepared in close collaboration with Dr. Travis, and embodying many new features of undoubted importance (Figs. 11 and 12).

The principles of the hydrolytic tank operation have been deduced from a prolonged study of sewage, and from exhaustive experiments relating to the special condition in which the suspended matters exist therein, as well as from extensive and

actual observations, conducted at Hampton, having reference to the nature of the operation occurring in all tanks.

These principles will be the more easily understood and the action of the tank more readily appreciated after consideration of these several factors.

The liquid portion of the sewage, having brought the impurities to the Disposal Works, has fulfilled its essential object. It is not, to any appreciable extent, beneficially affected by being submitted to a tank operation. Indeed, when this is a prolonged one, the liquid becomes deleteriously influenced by being saturated with the gases evolved from the decomposing sludge.

The liquid, however, contains suspended solids which require to be eliminated and which are of all grades, varying from the readily depositable gross matters and finer substances, together known as the solids in suspension, down to the infinitesimally fine colloidal particles, which are accounted amongst the solids in solution. The former of these can be arrested by an efficient tank operation; the latter are not depositable, under practical working conditions, unless they are brought into very intimate contact with surfaces.

The operation occurring in tanks differs in character, depending upon whether septic action is or is not permitted to take place. It is also modified in the former case by the amount of septic action as well as by the special behaviour of the sewage.

The operation in ordinary settling tanks is a simple one, for there are only two forces at work, viz. the onward flow of the liquid, and the rising and falling of the lighter and heavier particles. By the former of these forces the finer suspended matters are carried forward and issue in the effluent. By the combined forces the lighter and the heavier solids reach the surface and the bottom of the liquid, at variable distances along the tank. The depositing solids form a layer of sludge, to which each succeeding volume of sewage adds its quota. In this way a more or less rapidly rising floor of sludge results, which diminishes the liquid capacity of the tank, increases the rapidity of the flow of the liquid through it, and causes a larger proportion of suspended matters to pass out of it than is consistent with its successful working. Therefore the operation has to be stopped, and the tank has to be emptied and cleaned out.

The operation occurring in septic tanks is a complex one. Ordinary settlement, as herein described, does of course take place and the above-enumerated forces are engaged, but there is super-added a third force resulting from the decomposition of the sludge.

The septic operation has, very generally, been assumed to be a liquefactive one, and such tanks have, not uncommonly, been called liquefying tanks. Indeed, so-called "areas of liquefaction" have been described, but these have been shown, by the Hampton observations, to be merely liquid areas due to the separation of the sludge into a higher layer, the lower limits of which can be seen to be charged with gas bubbles, and the lower portion, containing fewer gas bubbles, with intervening liquid. Whilst a modicum of liquefaction does undoubtedly occur, as well as a small expression of the opposite condition of de-solution, the essential nature of the operation is a gasification. The amount of gas produced has usually been described as a percentage of the volume of sewage; but this is inaccurate, for gas production is absolutely independent of sewage volume, inasmuch as it is created by, and therefore is strictly proportionate to, the amount of sludge accumulations. The formation of gas is markedly influenced by temperature conditions, being active in the summer and practically dormant in the winter, but as an average for the year, and as the mean of many observations, the amount when referred to the sewage flow will be found to be approximately five per cent. The depositing matters, expressed as dry solids, will rarely exceed ·05 per cent., and will have to pass through the uprising gases. These gases therefore constitute a force opposed to and greater than that of the depositing solids. This complicates the operation, and is the chief explanation for the inadequate results, and for the large proportion of suspended solids which characterise septic tank effluents.

The effects of the gases may be manifested in one of two ways, according to the special behaviour of the sewage. In the first case, the gases are unable to escape freely from the deposited sludge, which becomes charged with minute gas bubbles, and which is either lifted bodily or in large masses to the surface, where it remains as scum. The gas makes an attempt to escape and fissures form in the scum, but before this can become effectual and the scum can fall, other portions of sludge

are floated up underneath that first described, which prevent it from re-depositing. The formation of scum continues until a mere channel for the sewage exists, through which solid fæces and unaltered paper are conducted to the effluent, which necessitates the cessation of the operation, and the removal of the scum contents of the tank.

In the second case, the gases can escape freely and are continually arising from the deposited sludge. At intervals portions of the sludge are carried up to the surface where, as no impediment to the easy escape of the gases exists, these become disengaged and the sludge falls to the bottom again. The depositing and re-depositing matters form a gradually rising floor of sludge which, unlike that referred to under simple settlement, is not fixed, but is periodically disturbed by the gaseous eruptions, and is gradually carried forward to the outlet of the tank. As the operation continues the sludge accumulations become more extensive, the gaseous disturbances more pronounced, and the character of the effluent more foul until ultimately the tank has become inefficient and its accumulations have to be removed.

Each form of tank operation has thus been shown to be determined by the increasingly foul character of its effluent, which has been occasioned mainly by the extensive sludge accumulations. These accumulations have clearly indicated the desirability, if they have not actually demonstrated, the necessity for periodical rather than for terminal sludge removal.

The principles associated with the hydrolytic tank may now be considered. These are—

(1) To exclude from any prolonged tank operation as large a proportion of the liquid as possible.

(2) To effect the sedimentation of the depositable contents of the sewage in such a way as will avoid the rising floor of sludge, which has been seen to interfere with and to terminate other tank operations, by substituting therefor a disappearing floor of liquid, which will increase the sedimentation efficiency and will make it perpetual.

(3) To separate the hostile forces of deposition and gaseous eruptions by limiting these operations to their own separate compartments.

(4) To prevent undue accumulations of scum and sludge by

periodically withdrawing that proportion which the special method of operating the tank may dictate.

(5) To correct the frequent outrush of disturbed deposited matters, the result of gaseous eruptions, by the re-deposition and removal of these solids in an additional chamber.

(6) To submit the entire volume of liquid to the attracting influences of self-cleansing surfaces in order to abstract as large a proportion of the finer suspended and colloidal solids as possible; and

(7) To maintain continuously the predetermined capacities of the tank.

These principles are, in the main, secured by dividing the tank, which is in its lower part wedge-shaped in transverse section, into three compartments by a longitudinal arch-shaped division, this shape having been adopted for constructional reasons. This arch has openings at its springings and its crown for liquid communication. The outlet end of the tank has a level weir, which is divided by the arch, so as to apportion a definite width of weir to each of the compartments. The two lateral compartments or chambers are devoted to sedimentation and the central to sludge reduction, the wedge-shaped portion being for sludge collection, and for its removal.

The cross-section of the hydrolytic tank is so admirable for facilitating rapid deposition and easy removal of solids in suspension that it has been adopted in the Norwich scheme for the detritus tanks.

The sewage will enter the sedimentation chambers only. The first volume which will flow into them will pass through the openings in the lower part of the arch into the wedge-shaped portion, which will become gradually filled by the succeeding volumes. As the sewage continues to flow, the liquid will rise equally in all the chambers until it is level with the weir; the communication between the reduction chamber and its outlet weir being upward through the crown openings in the arch, and thence along a channel carried by the arch. Thereafter the proportion of liquid passing through each of the chambers will be determined by the relative width of its weir to that of the others.

Numerous experiments have been made in order to ascertain the most advantageous division of the weir. The weir of Hampton hydrolytic tank was originally proportioned in the

ratio of 87·5 per cent. to the sedimentation chambers, and of 12·5 per cent. to the reduction chamber. It was subsequently altered, for experimental purposes, to 80 per cent. and 20 per cent. respectively. The former or even slightly higher percentages might be recommended in the case of a notably weak sewage, the latter would be more suitable for a comparatively strong one.

The period during which the liquid will have to remain in the several chambers has also been the subject of continuous investigations. These have shown that no commensurate advantage would accrue from a longer stay in the tank than four hours for the liquid passing through the sedimentation chambers, and twelve hours for the liquid flowing through the reduction chamber. They have also demonstrated that this rate of flow can be accelerated to, and to even less than, one and three hours respectively without either disturbing the sludge or giving rise to an excessive amount of suspended matters in the effluent.

The sedimentation chambers are more or less wedge-shaped on transverse section, and, as previously stated, receive the entire volume of sewage. Of this volume 80 per cent. will, in the Norwich tanks, traverse the chambers and will, on the average flow, pass over the weir at the end of the tank in four hours; whilst the remaining 20 per cent. will descend, through the openings in the arch, into the reduction chamber. In other words, the contents of the upper two-thirds of the vertical height of the chamber, representing 80 per cent. of the sewage, will constitute a forwardly moving force, which will carry the rising and falling particles some distance along the chambers. The light suspended solids will, by this and by their own force, reach the surface where they will be retained by the shallow scum wall near the weir. The contents of the lower third of the chambers, the representative of the remaining 20 per cent. volume, will be a downwardly directing force, or disappearing floor of liquid, into which the depositing solids will fall, and by which they will be conveyed into the reduction chamber. These solids will therefore only have to descend, in virtue of their own gravity, to the junction of the upper two-thirds with the lower third, before entering the volume which will carry them out of the chambers as a concentrated sewage. The degree of concentration of this liquid can be expressed by saying that

PLATE No. I.

FIG. 2A.

REES ROTURBO / ?BO,
?ENT CENTRIFUGAL PUM? / ?ATING PUMP.
CONSTANT SPEED 965 R.P.M. / 940 R.P.M.

SELF REGULATION.

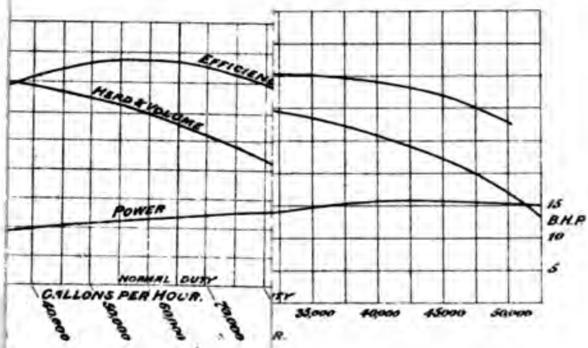
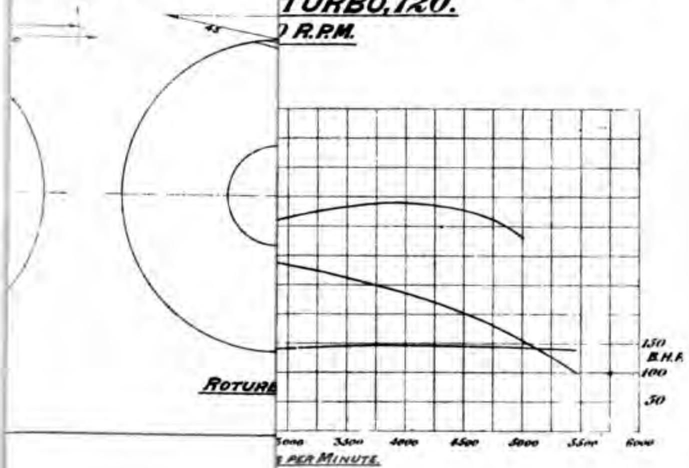


FIG. 4.

?LOCITY DIAGRAMS.

?TURBO, 120.
? R.P.M.



To face page 192.

the greater part of the original solids in suspension in 100,000 volumes of the sewage entering the chambers will be collected in the lower 20,000 volumes, which will pass out of the bottom of them.

The liquid itself will also be found to be of varying degrees of specific gravity. When it is heavier than the liquid contents of the chambers, it will descend and traverse the lower limits of the chamber to the end, and then gradually rising upwards will force the lighter liquid over the weir. When it is of lighter specific gravity, it will rise and travel to the end of the tank, on the surface of the heavier liquid, which will be gradually displaced downwards, into the reduction chamber. So that, under all circumstances, the depositing solids and the heavier liquid will pass through the openings into the reduction chamber, whilst the liquid containing the smallest amount of solids in solution will pass out of the tank.

The adaptability of these chambers to the high rates of flow of liquid through them, already alluded to, can now be easily understood, for if the contents of the upper two-thirds of the chambers pass rapidly through them, the contents of the lower third, conveying the deposited solids, pass as rapidly out of the bottom of them.

The principle of excluding as large a proportion of the liquid as possible from any prolonged tank operation will thus have been secured, for 80 per cent. of the liquid will usually have passed out of the tank in four hours. It is, however, necessary to submit the liquid to the attracting influence of self-cleansing surfaces or colloid collectors, hereafter termed colloid'ors, in order to obtain the benefit of that principle. This will be brought about by placing these colloid'ors in the end three-fourths of the chambers, whose dimensions are increased to provide for the capacity they occupy. The first fourths of the sedimentation chambers will not contain colloid'ors, and will be devoted solely to sedimentation purposes, which, in so far as the grosser matters are concerned, will be practically completed therein. In the end three-fourths the sedimentation of the less gross matters, and the abstraction from the liquid of the finer substances and colloidal solids upon the colloid'ors, will be in active operation until the liquid leaves the tank.

The capacities of these chambers will be always maintained,

for sludge will neither collect nor form in them, except such as becomes attached to all surfaces, and as the particular surfaces in this tank will be self-cleansing, the deposits will, when their weight overcomes the power of attraction, fall away from them into the reduction chamber.

The reduction chamber will be the recipient of the concentrated sewage, and will have the rate of flow of its liquid contents diminished to one-third of that in the sedimentation chambers, in order that the suspended matters may be deposited into its lower part, or sludge space. Whilst depositing its solids the liquid will flow forwards and upwards to the weir, over which it will on an average pass in twelve hours after it has entered the chamber. The action occurring herein will be a modified form of septic tank operation. There will be the same continuous formation of gas; the more or less periodical discharge of the gas so formed; and the concomitant disturbance of the sludge. The forward movement of the liquid will carry some small proportion of the disturbed deposited matter out of the chamber as well as project the re-depositing sludge some distance towards the outlet end. The disturbance will, however, be limited by reason of the smaller amount of sludge accumulations, owing to the periodical sludge withdrawals, and will only appertain to one-fifth of the sewage flow, and not to the entire volume, as in septic tanks. For whatever the disturbance in the reduction chamber may be, it will never be communicated to the sedimentation chambers, nor will the gases which occasion the disturbance ever contaminate the liquid flowing through these chambers.

The ratio of the depositable solids—the solids in suspension—to the converted matters may be sufficiently accurately expressed as three to one; that is to say three-fourths, or 75 per cent., of these solids will either appear in the effluent or must accumulate in the tank as scum or sludge. As the essential object of a tank operation is to adequately protect the effluent from suspended impurities, the excess accumulations of scum and sludge must therefore be removed if this object is to be effectually accomplished.

The scum has been assumed to be a desideratum, but this is not so. It is in reality a detrimental in that it acts as a barrier to the free escape of the gases, and in this way encourages a larger scum formation. It will, therefore, be regularly removed

from the sedimentation and reduction chambers by drawing it back to the scum outlet channels.

The periodical removal of the sludge, though it may be a matter of some difficulty in flat-bottomed tanks, will be easily effected from the reduction chamber. Numerous observations, however, have shown that it is altogether futile to attempt to do this from one outlet, for the liquid will come through when the angle of the sludge surrounding the outlet valve approaches to from 20 to 30 degrees above the horizontal. Therefore the bottom of the reduction chamber must be constructed as a series of inverted cones or alternatively pyramids having slopes of sufficient steepness, and provided with outlet valves at their bottoms to ensure the efficient removal of the sludge.

The character of the operation will, by these means, be brought under entire control. For if the chief desirability be to secure the maximum of sludge reduction, this can be effected by maintaining a high sludge level in the chamber. If, on the other hand, it be necessary to minimise gas formation, aerial nuisances, and malodorous effluent, this can be secured by keeping the accumulation of sludge down to its lowest possible limit.

The liquid issuing from the reduction chamber will be conducted to the hydrolysing chamber in order to correct the periodical issue of disturbed deposited matter from the former chamber, and to submit the liquid to the attracting influence of colloid'ors. These will be placed throughout the entire chamber, excepting in the lower part thereof, which will be reserved for sludge collection and withdrawal. The liquid will enter towards the bottom of the chamber, and will flow forwards and upwards around the colloid'ors to the weir, which it will cross in five hours on an average after it has left the reduction chamber and entered the hydrolysing chamber. The suspended solids which will have been carried over from the reduction chamber, and the matters which will be arrested by, and will fall from, the colloid'ors, will be periodically withdrawn through the sludge outlet valves. The scum which will form on the liquid in the chamber will also be regularly removed to the scum outlet channels.

The principles and practice of the hydrolytic tank operation have now been considered, and it is submitted that these considerations have demonstrated that the hydrolytic tank carries

the operation further, and more adequately protects the subsequent treatment area than does any other tank—not merely in correcting the outflow of suspended matter from it, nor solely in excluding a large proportion of the liquid from an unnecessary tank operation, nor even in causing to be removed a fair proportion of the finer suspended and colloidal solids from the liquid, but also in the efficiency of its provisions for, and the easy method of operating, the removal of the accumulations during the continuous work of the tank. Chemical precipitation tanks achieve some of these objects, but hardly to the same extent, and at no inconsiderable expense for chemicals, which not only add to the actual amount of sludge to be dealt with, but are also associated with less automatic methods of sludge collection and removal.

In conclusion, the writer affirms that if one fact more than another has been clearly set out in this communication, if practical experience also has demonstrated anything, it is the overwhelming necessity for sludge removal from all tanks, and the fact that this necessity increases in proportion to the clarity of the effluent. He desires to emphasise this, not only in relation to sludge removal, but also in regard to its subsequent disposal, the provision for which can scarcely be too ample in any sewage treatment area.

DISCUSSION.

The Chairman: Mr. Collins has clearly demonstrated the advisability of using reinforced concrete in the sewer he is constructing, and the fact that he has been able to construct such a sewer at half the cost of iron pipes will, at all events, tend to get rid of the opposition of the Local Government Board to reinforced concrete.

Dr. Travis: I have to congratulate Mr. Collins on the very lucid manner in which he has described the working of the hydrolytic tank, and the several methods of removing the solid matters from the sewage. Mr. Collins particularly desires that I should refer to the condition in which these solid matters exist in sewage, more especially that of the minuter particles. In the sewage of Norwich there are on an average per 100,000 parts, 68 parts suspended matter, which would deposit in two

hours' quiet settlement, and should be regarded as gross solids, capable of being removed by a tank operation. In addition to these there are about twelve parts, consisting of fine particles, which will not deposit in the time stated, nor can they be removed by an ordinary tank operation, but as they can be arrested on a filter paper they are recorded with the 68 parts as the solids in suspension. Beyond these there are particles in colloidal solution, which constitute about 20 parts per 100,000, and which do not differ except in size from the gross or the fine particles. These particles can be demonstrated by the ultra-microscope, an instrument which has been constructed during the last five years, to be definite, and to be in a suspended condition. It is just as necessary to remove these from the sewage as it is either the fine or the gross substances. Not only so, but this removal must take place before the sewage can be purified. It occurs when sewage is placed on land, in a filter, or is discharged into a river. When sewage is treated by dilution—a method in vogue in America—the deposition of these solids, the gross, the fine, and the particulate, is evidenced by accumulations along the bed of the river. The idea of placing sewage in a river is that the oxygen contained in that river will destroy the organic matter discharged into it. The oxygen content will, up to a certain point, oxidise the products which have been created on the bed of the river, but the bulk of the matter remains, and gradually accumulates until the river becomes practically a septic tank. Mr. Collins rather wishes me to mention the ultra-microscope to show that the colloidal matters are in a condition of suspension. In operating this instrument an ordinary microscope with a high power is used, and a very intense but very minute beam of light is passed through the liquid under examination. This intense light becomes diffracted from the surfaces of the particles, which are about a six millionth of a millimetre in size. The size of the smallest object which can be seen by a microscope is about a seven-thousandth of a millimetre. In observing a liquid by the ultra-microscope the particle itself is not seen, but its diffraction disc—the light surrounding the particle—is observed. Each particle is distinct, and is in continuous movement, whether moving in its orbit or in its ellipse. One point of practical moment has been established in the Hampton research laboratory, and that is that the gross matters can be converted

into colloidal solution by agitation. This has actually been done, even after the matters had been deposited for some time. We had a sample of an effluent which had deposited its colloidal solids for twenty-two months, and the liquid of which was perfectly transparent. This was placed in a revolving vessel for twenty-four hours, and at the end of that time, a fairly large proportion of the deposit was thrown into colloidal solution. In the conveyance to an outfall by gravitation, the sewage will not contain a large proportion of matters in colloidal solution; the colloidal matter will be in a gross condition. If the sewage is held up in the sewers for a long time, or if it be agitated on the way to the sewage works, then a large proportion of the colloid matter will be found to be in colloidal solution. If the gross colloid matter be submitted to tank treatment, and if it remained in the tank for any prolonged period, it would, in great part, be thrown into colloidal solution. The method of removing this is by bringing it into contact with surfaces. If the colloidal solution were left in a vessel, in the course of time—a week, a fortnight, or longer—the colloid would come out of solution and would form a deposit on the sides and bottom of the vessel.

The Chairman: There is one thing I should like to ask. After you have got rid of the gross, the fine, and the colloidal matter, how much is left in solution?

Mr. S. H. Chambers: I would like to move a vote of thanks to Mr. Collins for inviting the Association to Norwich, and also for the paper which he has presented to us. I am particularly interested in the hydrolytic tank, as my authority at Hampton were the first to instal the tank, and it has now been in operation for the past four years. A model tank has also been under working conditions during the same period; and the actual work which Mr. Collins anticipates in the tank proposed for Norwich has been going on in my district uninterruptedly during that time. Mr. Collins has the advantage of me, for he has had the benefit of the experience obtained, and the experiments carried out at Hampton in designing my tank, and I expect in the future Hampton will be left behind and Norwich come to the front.

With regard to the ultra-microscope, I am pleased that Dr. Travis has mentioned it, because at the Hampton meeting it was asserted, when I stated that colloidal particles could be

seen, that the instrument had yet to be invented, but I have seen these colloids by the aid of the ultra-microscope myself.

The design of the Norwich tanks is an admirable one, and in many ways an improvement on the one at Hampton.

THE CHAIRMAN: I have much pleasure in seconding the vote of thanks to Mr. Collins.

MR. E. J. SILCOCK: I think the principle involved in these tanks is an important departure in the problem of the separation of the solid matter of sewage, and it is one of the results of which we shall all look forward to with great hopes that they will be successful. The principle, as far as I can understand it, is to submit the sewage to the largest amount of surfaces that can be presented to it, so that attraction may take place between those surfaces and the extremely minute particles in suspension. The method of suspending the colloid'ors in the way Mr. Collins proposes is an excellent arrangement. At the Hampton works the hydrolysing chambers are filled with flints and large stones which do not lend themselves so readily to cleansing as the inverted plates in this instance. The main, constructed of Bonna reinforced concrete, is also a new departure as far as sewage works are concerned. It is a system well adapted to the purpose where internal pressure has to be resisted. Some five or six years ago I remember trying some experiments with reinforced concrete pipes. The culvert which was proposed to be made was an inverted syphon, and the reinforcement in that case was to be carried out with expanded steel. The great difficulty we had was to make the concrete sufficiently watertight to withstand the pressure. It did not occur to us to make a core or hoop of steel. That addition in these pipes seems to give all that is required. The details of this have been worked out in a very practical way. The joints between one pipe and another are exceptionally strong, and the special pipes can be moulded on the site to suit the particular requirements of the case as they arise, without being sent to a foundry. These are good features.

MR. H. W. TAYLOR: To effect purification of sewage one must separate the solids from the liquid, and until that is done trouble will result either in the tanks or filters or in both. There are certain works and places where one gets a precipitant with the sewage itself. I refer more particularly to the pottery towns, where a large amount of china clay, in a finely divided

form, gets into the sewage and is carried down in the sewer to the disposal works. This clay will settle, if it is given time, and as it settles it attracts those minute particles—the colloidal matters—and carries them to the bottom of the tank. In a similar manner, at sewage works in colliery districts, where the colliers get their coals gratis, one will always find a considerable amount of fine ashes and coal dust carried down the sewers, which also act as a precipitant. Therefore, if the sludge is run off regularly under those two special conditions, you will get better results than with a sewage with no natural precipitant in it, but in the majority of cases these conditions are not present. When the sludge settles, it generates gases which constantly rise in the form of bubbles, and thus these solids and gases are opposing elements. At Hampton there are 420 parts per 100,000 of *wet* sludge on the one side, while opposed to that there is an average of 6¼ per cent. of gases generated throughout the whole of the 12 months. (It will be more in the summer, when the temperature is higher and bacterial life is more active, and less in winter, when the temperature is low; but 6¼ per cent. is the average throughout the year.) That means 6250 parts per 100,000 of gases rising, against which there are 420 particles of wet sludge trying to settle. That gives us some idea of the opposing forces that are going on in an ordinary septic tank. As a bubble rises to the surface of the tank it forms a very slight vortex, but it is sufficient to carry a small particle of sludge with it. If one watches at the outlet of the tank one will see these little bits of sludge going over, and *that* is where the sludge is going. It does not stop at the bottom of the tank—except a very small proportion—and consequently the experiments reported at Exeter are true in a certain sense. The sludge does not stop in the septic tank, but is carried forward to be dealt with in the filter or contact bed. In the hydrolytic tank which is being constructed at Norwich, 80 per cent. of the sewage goes through the side chambers, and only 20 per cent. goes through the central chamber. The sewage carries with it to the centre chamber nearly all the grosser solids, and therefore one gets rid of that disturbance which goes on in a septic tank. I think this new tank has all the advantage of every other tank I have seen, and it has many features of its own, and I believe it to be the best up-to-date. I have constructed a small hydrolytic

tank, which has only been at work for two or three weeks, therefore it is too early to speak of its results as yet, but so far it is answering well and quite up to expectations. There is one other point I should like to emphasise, and that is that engineers are naturally very sceptical of accepting anything new, especially in sewage disposal. Results and analyses have been put before me many times, but the majority of experiments and analyses have been over such short periods that they are not sufficient to convince me they were right. The Hydrolytic Tank Company were very wise, they did not bring forward their tank until it had been in operation three or four *years*, and the results are founded, not upon a few but upon thousands of analyses carried on regularly from day to day over three or four years. It must follow that if they are able to get consistently good results over that period of time, the system is worth careful consideration.

MR. G. A. HART: Sufficient regard to detail in design, dependent upon the form of treatment to be adopted, is essential if the best results are to be obtained from such treatment; and in this respect the design of the hydrolytic tank appears to be exemplary. As long as the circumstances and conditions which envelope the problem of sewage purification in our municipalities continue to vary, as they do at this time, it appears to me to be altogether impracticable to anticipate that the sludge of our varied localities can be treated in the manner provided for in the hydrolytic tank.

This treatment is, of course, the means to an end, and under certain conditions may be said to be the wrong remedy for a specific complaint. As typical of this, one may be allowed, perhaps, to refer to the conditions which prevail at Leeds, where we, as an authority, are situated in a most unfortunate position, determined almost entirely by the physical features of our locality. Were we able readily to dry to controllable form a large mass of liquid sludge in good open land, then one could see the great advantage which this form of treatment would present.

Unfortunately we are not so placed. Our land is generally stiff clay and low-lying to the river, and it has been found necessary to adopt totally different treatment to our sewage and sludge in order to render ourselves immune from the grave danger of an ungovernable nuisance arising.

It occurs to me, however, that I do not see why this general

design of tank should not be with advantage adapted to a precipitative process, although I am not aware whether it has been in any case tried in this way.

MR. A. BURTON: If Mr. Collins will put in the paper some rough idea of the analysis of the sewage, it will be a great guide to those who have to adapt such works to their own towns. I should like to ask whether the liquid from the sedimentation tanks goes upon what are generally known as bacteria filters, and, if so, whether, when application was made to the Local Government Board, they relaxed in any way their requirements as to area. It does seem to me, from the paper and statements which have been made, that when not only a large amount of gross and fine, but of colloidal, matters are taken out of the sewage, that such a large area will not be required as is generally insisted upon by the Local Government Board. Further, I should like to know if we can have a rough comparative idea of the capacity of the tank to dry-weather flow. We shall then have some idea of the proportion of the dry-weather flow to be calculated for. Then there is the question of the colloid'ors. Mr. Collins says the colloid'ors will be made of wood, but does not state what kind of wood he proposes to use. I presume one with the closest grain would be the best for the purpose. The next point is the emptying of these tanks. I understand Mr. Collins to say they are to be emptied every day. Does he think the proportion of sludge removed from these tanks is a serious item?

MR. EDWIN AULT (Westminster): I am much interested in what Mr. Collins has said about the Roturbo pump, but he will forgive me if I utter a word of caution to the members with respect to the efficiency of the pump. It has been stated that the efficiency is 70 per cent. at normal head and volume, and that the efficiency does not greatly vary when the head and volume are inversely variable, or, in other words, when the product of head and volume have a constant value. This may be true, but when a constant head has to be maintained while the volume is variable, such as will be the case when pumping direct into town mains, the efficiency of the Roturbo, in common with all centrifugal pumps, will become lower and lower as the volume discharged from the pump decreases, while the head is maintained.

I can corroborate what Mr. Collins has said about the

serious stress of pipes and joints by wave or oscillatory action of water, from a recent experience in connection with a 42-inch cast-iron main delivering water by gravity to a pump well, the discharge end of the main being open. As the pumping of water was intermittent, the supply to the well had to be closed twice daily. The main, for a length of about 2000 to 2500 feet back from the well, is laid quite level, and, in consequence, the surface gradient of the water flow is such that the pipe is only about half full at the discharge end. In closing the valve on the outlet, no matter how slowly it was done, a large volume of air was locked in the pipe, and severe water hammer occurred every time the valve was shut down. This did serious damage to the lead joints. A vent pipe was placed on the pipe at the back of the valve, which considerably improved matters, but the oscillations of the water were sufficient to send jets of water through the vent-pipe 40 or 50 feet high. Later a 6-inch bye-pass was put on the pipe round the main valve, and was allowed to remain open for some time after the large valve was closed. This so far improved matters that the occasion for repair to joints was practically done away with; but even after these alterations I have known the oscillations of the water within the 42-inch main to continue for three-quarters of an hour subsequent to the closing of the main valve, as evidenced by the puffs of air at the vent-pipe.

With regard to the cost of electrical pumping as compared with steam power. I have recently gone through a number of tenders in response to an advertisement for pumping plant to deliver 10,000 gallons of water per minute against a total head (including suction and friction) of 220 feet. Owing to certain decisions of the purchasing authority, the plant will for some time deliver into the town mains at the reduced head of about 150 feet, and the volume pumped will vary largely as the draw off by consumers, owing to small reservoir capacity. The pump-makers tendering were allowed a free hand as to the class of plant they would supply, and they were to guarantee the working cost. Amongst a number of tenders received one was for an electrically driven plant with centrifugal pumps, and the working cost for current, without reckoning establishment charges, came to some four times the cost of fuel for the steam-driven plant, the cost of the current being $1\frac{1}{4}d.$ per B.T.U.

Monsieur A. L. LANSEIGN (Paris): I wish to thank Mr.

Collins and all the officials of the Norwich Corporation for the assistance and kindness received from the time of starting the manufacture of the pipes here. The President of the French Republic during the week has cemented the *entente cordiale,* but that was cemented at Norwich six months ago by the kindness to the French officials, who were sent here to superintend the manufacture of the pipes. You will have an opportunity of seeing the work of manufacture and laying of the pipes from beginning to end. To enumerate the contracts my firm have carried out and have in hand would show that it is not a new thing, and that its efficiency has been proved.

COMMUNICATED REPLY.

MR. COLLINS: In answer to the Chairman's question, it is expected that a purification of 60 per cent. will be effected by the Travis tanks.

In reply to Mr. Burton's inquiry as to analysis of Norwich sewage, the samples were taken hourly for twenty-four hours on May 20, 1908, and are as follows:—

Solids in suspension	= 79·6	
Solids in solution	= 85·4	
Organic solids in solution	= 39·8	
Colloid solids in solution—		
After two hours' settlement	= 31·0,	organic = 20·6
„ filtration through paper	= 19·4,	„ = 12·4
„ „ „ asbestos	= 17·6,	„ = 11·6
Chlorine	= 8·6	
Ammoniacal nitrogen	= 8·0	
Albumenoid nitrogen	= 2·18	
Albumenoid nitrogen in colloids—		
After two hours' settlement	= 0·45	
„ filtration through paper	= 0·33	
„ „ „ asbestos	= 0·2	
Oxygen absorptions	= 12·3	

As to Mr. Burton's question respecting the treatment following the Travis tanks, the tank effluent will be irrigated over 200 acres of the existing sewage farm. On Dr. Travis's recommendation the Corporation have undertaken that the effluent from the tanks shall be equal to the effluent from a tank in which the sewage is subject to chemical treatment. This undertaking has resulted in the Local Government Board not requiring the provision of filters or contact beds previous to

irrigation. The combined capacity of the tanks equals 0·23 of the average daily dry-weather flow. The colloid'ors will be made of any suitable wood which can be bought at a fair price, probably Jarrah. The Author has considered various arrangements for ascertaining when the drawing off of sludge should cease, but is at present of opinion that the proper time for such cessation must be decided by practice. The sludge will be disposed of by pumping it to the higher levels of the farm, where it will be run into trenches in the same manner as has been adopted by Mr. Watson of the Birmingham sewage farm. The Local Government Board insisted on the sludge being taken to the higher levels instead of gravitating to the lower parts of the farm, their reason being that the higher levels would not be available for irrigation, whilst the lower levels would. In answer to Mr. Ault's inquiries, the diagrams of tests of Rees's Roturbos—some of which were prepared in the presence, and with the assistance, of the Author—show the variations of efficiency as compared with head and volume. It will be noticed that through quite a considerable range the efficiency does not vary much. Of course in pumping directly into a town main there are times when there will be no efficiency whatsoever by reason of there being no flow, but it would not be advisable to use any type of centrifugal pump for such pumping. By pumping into a tank, which need not of necessity be very large, efficiency can be relied on.

The Author quite agrees as to the excessive cost of electrical pumping as compared with the cost when good steam or suction gas plant is used, but this disadvantage of electricity disappears when relatively small quantities have to be pumped intermittently because of the labour saving arising from automatic working. This assumes the supply of electricity at a reasonable price.

The Members drove in brakes to Trowse, where an opportunity was afforded of seeing the Roturbo engines and the earlier stages in the construction of the Bonna reinforced concrete pipes. The party afterwards proceeded to Whitlingham, where they were most hospitably entertained to luncheon by the Sewage Committee, and the remainder of the afternoon was occupied with the inspection of the work in progress, the manufacture and the laying of the Bonna reinforced pipes.

LANCASHIRE AND CHESHIRE DISTRICT MEETING.

June 13, 1908.

Held at Blackpool.

J. A. BRODIE, M.ENG.,WH.SC.,M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members assembled in the Council Chamber at the Town Hall, where they were received by the Mayor (Alderman J. Battersby, J.P.), who very heartily welcomed them to Blackpool.

The President thanked the Mayor for his kind welcome.

BLACKPOOL AND SOME OF ITS MUNICIPAL WORKS.

BY JOHN S. BRODIE, M.INST.C.E., BOROUGH ENGINEER AND SURVEYOR.

IT will be convenient to describe very briefly the various Municipal Works and Undertakings, which are the subject of this Paper, in the following order, viz.: 1. Historical. 2. Physical Features. 3. General Statistics. 4. Sea Defence Works. 5. The Promenades, Foreshore, and Sands. 6. Carriage-ways. 7. Footpaths. 8. Private Street Works. 9. Tree Planting in Streets. 10. Lytham Road Bridge over Railway. 11. Sewerage and Sewage Disposal. 12. Refuse Destructor. 13. Highway Depôts and Municipal Workshops. 14. Stables and Depôt. 15. Public Conveniences. 16. Open Spaces.

17. Sea-Water Supply Works. 18. Sanatorium Extensions. 19. Two New Council Schools. 20. Allotments. 21. Corporation Land Estates. 22. Public Mortuary. 23. Cemetery Extensions. 24. Building Bye-laws: New Buildings. 25. Water Supply. 26. Gas Works. 27. Electricity Works. 28. Tramway Undertaking. 29. Street Lighting. 30. Street Cleansing and Refuse Removal. 31. Town Hall. 32. Police Courts and Stations. 33. Fire Brigade Depôt. 34. Wholesale Market. 35. Public Slaughterhouse. 36. Public Libraries.

The Author is directly responsible for the construction of the Works, and the maintenance of the same, in regard to items 4 to 24 inclusive, while he acts in a consultative and constructional capacity, as occasion arises, in regard to most of the other items.

1. Historical.

The County Borough of Blackpool is situated at the westward or seaward extremity of that part of West Lancashire known as the "Fylde." The Fylde country has never been clearly defined, but may be roughly described as bounded by the rivers Wyre and Ribble on the north and south respectively, by the sea on the west, and by an imaginary line drawn from Preston to Garstang on the east.

The name "Blackpool," derived from the existence of an ancient peaty-coloured lake or "pool" half a mile inland from the foreshore, and about 800 yards in width, came first into use in the reigns of Mary and Elizabeth. During the reign of Charles II., Edward Tyldesley, eldest son of Sir Charles Tyldesley of Tyldesley, erected a hunting-lodge on a site now known as Tyldesley Terrace. Towards the end of the seventeenth century the hunting-lodge was extended into a large country seat. Gradually a village grew up around the country mansion, and in time many visitors were attracted to the locality by the recuperative properties of the sea-breezes, the expansive sands, and the excellent bathing facilities to be found.

On October 23, 1851, the first Local Government Authority for the district was constituted, consisting of nine members, under the name of the Layton-with-Warbreck Local Board of Health.

On July 31, 1868, this name was altered to the Blackpool Local Board of Health.

In 1871 the number of members of the Local Board of Health was increased from nine to eighteen.

On January 21, 1876, a Charter of Incorporation was granted, the Council consisting of six aldermen and eighteen councillors, and the borough was divided into six electoral wards.

In 1879 the area of the borough was considerably extended, and the boundaries of the present six wards were defined by the Blackpool Improvement Act, 1879.

In 1898 the number of aldermen was increased from six to twelve, and the number of councillors from eighteen to thirty-six, while the number of wards remained at six. Each ward is therefore represented by two aldermen and six councillors.

On August 27, 1898, a separate Commission of the Peace was granted to the borough.

On October 1, 1904, Blackpool was constituted a County Borough.

The following figures will show the remarkable growth of Blackpool during the latter half of the nineteenth century:—

	1851	1861	1871	1881	1891	1901
Population ...	2564	3907	7092	12,987	21,970	47,338
Rateable value ...	—	—	—	£104,909	£178,377	£427,398

2. Physical Features.

Geologically, Blackpool, as well as álmost all the Fylde country, is, superficially, in the tertiary and post-tertiary systems.

Roughly, the northern half of the borough is composed of the upper boulder clay overlying the "Drift," and drains inland from the sea-front at an elevation there of about 75 feet above O.D., in an easterly direction to a natural lake known as Marton Mere, over two miles from the sea-front. Marton Mere has an area of about seven acres, and overflows at about 20 feet above O.D., through an artificial channel, cut about sixty years ago for drainage purposes, in a north-easterly direction, and now discharges into the river Wyre at Skippool. Previous to the artificial watercourse being made, the mere discharged into the sea at the same point as the southern section.

The southern section of the borough is part of the great Marton Moss, having about 5 to 6 feet of blown sand, blue and

white silt, known locally as "slob," and has a natural drainage by a small stream, called Spen Dyke, discharging into the sea, near Tyldesley Terrace.

3. General Statistics.

The Registrar-General's estimated residential population, at June, 1907, was 62,420. Rateable value, 1908, is about 495,000*l.*

Area of Municipal Borough, exclusive of foreshore,	3496 acres.
Area of foreshore	748 „
Total area of Borough	4244 acres.

The death-rate last year was 11·59 per 1000.

The total rainfall for last year was 33·35 inches.

Total rates:—General District, Borough, Poor, and Education, 5*s.* 6*d.* in the pound.

Blackpool is, by rail, 18 miles from Preston, 39 miles from Lancaster, 47 miles from Liverpool, 49 miles from Manchester, 77 miles from Leeds, 122 miles from Birmingham, 227 miles from London.

The supply of gas, electricity, and sea-water, as well as the tramways, are all owned and controlled by the Municipal Corporation, and the water-supply is the property of a publicly elected body called the Fylde Water Board, hereinafter more particularly referred to.

4. Sea Defence Works.

In 1778 the county historian, Mr. Hutton, wrote: "One of the leading amusements at Blackpool is to ride or walk; another is to figure on the parade. This is a pretty grass walk on the verge of the sea bank, divided from the road with white railing. It is perhaps six yards broad, and two hundred long, with an alcove on one end only, but at the other a wide pond or pit." "This parade," continues the prophetic Hutton, "is capable, by Art improving Nature, of being made one of the most beautiful walks on the island. It might easily be extended to a mile, in a straight line, and at no great expense, with an alcove at each end."

In 1828 it is recorded that "a fine gravel promenade was laid out on the sea bank to a considerable distance, occupying a large portion of the site of the old road" referred to by Mr. Hutton.

In 1856 the promenade was extended from Talbot Square to what is now known as the Hotel Metropole.

The erosion of the coast becoming more and more serious, Parliamentary powers were sought in the early sixties to protect the sea-front. The first Bill promoted in Parliament by the then Local Board was unsuccessful on financial grounds, as it was proposed to levy a rate equally over the district to meet the cost of the works necessary for protecting the front, whereas the Lords' Committee in Parliament decided that such cost should be borne only by those having property on the front, who would be directly benefited by the improvement.

In 1865 an Act was passed by Parliament containing a clause that a special parade rate should be levied on all frontagers. That Act is still in force.

Under the powers of the 1865 Act and a supplementary Act (1868) increasing the borrowing powers of the Board, the sea defence works and promenade, extending from Carlton Terrace to the further end of South Shore, a distance of about two miles along the sea-front, were completed, and opened on Easter Monday, April 18, 1870, at a total cost of about 88,000*l.*

In 1876 that part of the sea-front extending northwards from Carlton Terrace to the Gynn, a distance of about 1267 lineal yards, the property of the Claremont Estate Company, was sloped and stone-pitched, and a broad marine parade and drive made, all at the cost of the Company. The erosion on this part of the front was, however, so constant and serious that, in 1893, the Corporation promoted and obtained an Act of Parliament, authorising the borrowing of 50,000*l.* for the purpose of constructing new sea defence works and promenade. The works, which were carried out under the supervision of Mr. J. Wolstenholme, Assoc.M.Inst.C.E., then Borough Surveyor, were found to be very tedious and costly in execution, and were not completed and opened until 1899, at a cost of 144,716*l.*

It was, about the same time, found that the 1865 promenade (from Carlton Terrace to South Shore) was rapidly becoming inadequate to cope with the ever increasing annual

influx of visitors, so in 1899 a scheme for widening that part of the promenade seaward for a uniform extra width of 60 lineal feet was sanctioned by Parliament, at an estimated cost of 345,000*l.*

A short length (about 240 lineal yards) from the extreme south end to Victoria Pier was commenced and completed in 1900, at a cost of 6036*l.*

The Author having been appointed Borough Surveyor and Engineering adviser to the Corporation in September, 1900, was directed by the Council to re-consider and report on the whole scheme of widening as sanctioned by Parliament, and for that purpose to inspect most of the sea defence works in this country and on the continent. Acting on his report, the Council decided to increase the widening from 60 feet to 100 feet (except opposite the three piers, agreements with the proprietors of which having been scheduled in the Act of 1899 on a 60 feet basis). The requisite authority for the extra widening having been obtained from Parliament by the Blackpool Order (No. 1), 1902, the work was proceeded with at the South Shore end in June, 1902, and completed and opened, as far as Talbot Square, on July 25, 1905, a distance of 3184 lineal yards, at a cost of 304,000*l.* As already stated, the total length sanctioned by Parliament was 3584 lineal yards, and the total Parliamentary estimate was 345,000*l.*, so that the cost *pro rata*, so far as completed, was about 2500*l.* within the estimate, although the added width had been increased from 60 feet to 100 feet, and the plant in stock has been treated as capital.

5. The Promenades, Foreshore, and Sands.

The total length of the foreshore, or sea-frontage, is 4 miles 167 yards.

The length of frontage protected by sea defence works is 2 miles 6 furlongs 11 lineal yards.

The area of the promenade south of Talbot Square is 171,521 square yards, and that of the promenade north of the same point is 50,257 square yards, or together 221,778 square yards, equivalent to about 46 acres of promenading space.

South of Talbot Square the following are the widths:—

Promenade proper, average	80 feet.
Tramway space for double line, from 17 feet 6 inches to 20 feet 6 inches.	
West footpath	10 feet
Carriage-way	40 "
East footpath	15 feet to 30 "

From Cocker Street to the Gynn the widths are:—

Lower Promenade or Walk	15 feet.
Middle ditto	50 "
West footpath	15 "
Carriage-way	30 "
East footpath	9 "

The area of the sands at low-water mark of an ordinary spring tide is 1175 acres; at mean low-water mark the area is 748 acres.

The range of an ordinary spring tide is 27 feet, but tides have been actually measured in recent years with a range of 32 feet 9 inches.

The flow of the tide is from south to north, the ebb from north to south-west.

There is an average depth of about 6 feet of sand over the foreshore, and under the sand is a bed of stiff clay, of varying depths. There is no treacherous bottom or "quicksand" on any part of the foreshore, although during temporary shifting of the sandbanks the sands may be more consolidated, for short periods of time, at one place than at another.

6. Carriage-ways.

The main thoroughfares are from 45 feet to 60 feet in width, with carriage-ways 33 feet to 40 feet in width, and two footways each 8 feet 6 inches to 12 feet in width.

The ordinary front streets, under the Borough Bye-laws, are not less than 36 feet in width, with a carriage-way 21 feet wide, and two footways each 7 feet 6 inches in width.

Back streets are regulated in width by a local Act, and may be not less than 12 feet in width if required by the Corporation. They are usually from 9 feet to 12 feet in width.

A few passages are from 4 feet to 6 feet in width.

The length of front streets in the borough is, at present, about 69¼ miles, formed as follows:—

Description of Paving.	Area in square yards.	Cost per square yard laid complete, including foundation.
		s. d.
Haslingden setts, 6" to 10" long, 4" to 6" wide, 6" to 6½" deep, on 7" hand-set pitched foundation ...	316,800	6 6
Soft wood blocks, 3" × 4½" deep, on Portland cement concrete foundation 6" deep	12,675	6 1½
Australian karri and jarrah, 3" × 4½" on Portland cement concrete foundation	95,928	13 5
Tar macadam, 5" in thickness, on hand-packed rubble foundation 8" deep	55,805	5 9
Macadam, 5" Penmaenmawr granite on 7" hand-packed rubble foundation	823,680	3 9

The average costs, per lineal yard of streets, including carriage-ways, footpaths, gulleys, connections, and under-drainage (but not sewers), crossings, kerbs, and channels, are—

For streets 36 feet in width, 3*l.* 1*s.* 10*d.* per lineal yard.
" " 12 " " 1*l.* 8*s.* 0*d.* " " "
" " 9 " " 1*l.* 3*s.* 9*d.* " " "
Haslingden kerbs 12 inches by 8 inches, 3*s.* 10*d.* per lineal yard laid.
Ditto channels (paved setts) 2 feet in width, 5*s.* 8*d.* per lineal yard laid.

7. Footpaths.

The footpaths in the borough are from 6 feet to 12 feet in width, and are of a combined length of about 124 miles. They are formed as follows:—

Description.	Area in square yards.	Cost per square yard laid complete, including foundation.
		s. d.
Yorkshire flags, 3" in thickness, bedded on 3" bed of sand, pointed in black lime mortar	246,752	4 11
Lancashire flags, 3" in thickness, bedded same as above	188,338	4 11
Caithness flags, 3" in thickness, bedded same as above	20,836	6 2
Portland cement concrete flags, 2½" in thickness, bedded same as above	25,860	4 3
Tar-asphalte, 3" in thickness, exclusive of any foundations	126,205	1 9
Gravel, 1½" to 2" in thickness	7,010	0 11
Clinker, about 3" in thickness	15,840	0 4½

8. Private Street Works—Summary Statement.

The following table shows particulars of work done for eight years ending March 31, 1908, in making up private streets within the borough under the Public Health Act, 1875.

In all cases front streets are formed in macadam with York flagged footways, and back streets are paved with Haslingden setts. Passages are flagged with York flags.

Year.	Front Streets.						Back Streets.						Passages.						Totals.					
	No.	Length.		Cost.			No.	Length.		Cost.			No.	Length.		Cost.			No.	Length.		Cost.		
		ft.	ins.	£	s.	d.		ft.	ins.	£	s.	d.		ft.	ins.	£	s.	d.		ft.	ins.	£	s.	d.
1900–1901	26	15,182	1	14,491	7	8	26	6,671	4	4,516	0	6	—	—	—	—	—	—	52	21,853	5	19,007	8	2
1901–1902	12	4,674	11	7,674	1	3	32	7,084	5	4,620	14	4	4	210	0	59	9	11	48	11,969	4	12,354	5	6
1902–1903	7	1,446	9	1,459	4	9	32	5,388	9	3,935	7	10	5	533	10	152	19	0	44	7,369	4	5,547	11	7
1903–1904	12	3,445	9	3,822	13	10	62	12,007	1	9,108	8	10	2	196	0	58	4	10	76	15,648	10	12,989	7	6
1904–1905	8	2,146	2	2,201	14	0	43	8,629	4	5,402	2	0	5	609	0	148	12	3	56	11,384	6	7,752	8	3
1905–1906	8	2,950	9	3,094	15	10	30	6,498	1	4,051	12	6	4	455	0	85	18	3	42	9,903	10	7,232	6	7
1906–1907	15	5,357	11	4,359	9	10	46	7,073	9	3,256	18	10	8	866	10	177	19	3	69	13,298	6	7,794	7	11
1907–1908	7	2,498	0	2,098	5	10	26	4,282	3	1,919	7	6	9	787	9	168	11	9	42	7,568	0	4,186	5	1
	93	37,702	4	39,201	13	0	297	57,635	0	36,810	12	4	37	3658	5	851	15	3	429	98,995	9	76,864	0	7
		= 7·14 miles						= 10·91 miles						= 0·69 miles						= 18·75 miles		Average 9,608	0	1

9. Tree Planting in Streets.

The following are the trees which have been planted, under the Author's directions, during the last two or three years :—

156 *Acer Pseudo-platanus*, or Common Sycamore. These are doing well.

138 *Ulmus Montana Wych*, or Scotch Elm. These are also doing well.

10 *Ulmus Campestris Wheatleyii*, Elm. Do not flourish well in Blackpool, and will have to be taken out.

10 *Ulmus Campestris*, English Elm. Do not flourish well in Blackpool, and will have to be taken out.

Total 314, at a total cost of 636*l.* 16*s.* 7*d.*, equal to an average of 2*l.* 0*s.* 7*d.* per tree, which includes preparation for and planting, tree-guards, cast-iron grids, 3 feet by 3 feet, let into the flagging, stakes, etc.

The trees are planted from 15 to 25 feet apart, as far as possible in streets running north and south, so as to be sheltered from the prevailing westerly and south-westerly gales.

It is found that the forest trees most suitable for Blackpool are the Maple and the Common Sycamore. The next best is the Elm, Wych or Scotch.

The local conditions here are somewhat unfavourable to tree planting in streets, as the westerly gales are, in some periods of the year, extremely strong.

10. Lytham Road Bridge over Railway.

The above bridge and approaches were rebuilt during the winter of 1906–7, at a cost of 8000*l.*

The old bridge and approaches were built under the powers of the Blackpool and Lytham Railway Act, 1861. Lytham Road is the main approach to Blackpool from the south, and is 60 feet in width, and perfectly straight and level for a distance of 1 mile 6 furlongs 107 yards, from the borough boundary inwards to Wellington Road. By the easy complaisance of the Local Authority of the time, the Railway Companies, in 1862–3, carried the railway under this fine road by means of a bridge having cast-iron girders and brick abutments, 36 feet in width between parapets, and 30 to 32 feet in width at the approaches

(not more than half the width of the road), and at an angle of 20 degrees with the centre line of the road. The result was most unfortunate, and when a tramway was laid in this road in 1895, dissatisfaction gradually increased until, in 1905, the Corporation obtained a special Act of Parliament to straighten and widen the bridge.

The new bridge, built from the Author's plans, is 50 feet in width between parapets, or 10 feet narrower than the road, and is in a straight line with Lytham Road. It was found impracticable to get the full width, as certain important contiguous buildings had arisen since the old bridge was built. It is built of steel plate girders on Accrington plastic facing brick abutments, with Nelson stone facings and copings. The foundations were carried down to 12 feet below rail level, through the peat on to the blue silt, as the borings showed that no better foundation was available at a depth of 30 feet. On the blue silt a double layer of 4 inches thick pitch-pine planking was laid diagonally, and on this planking Portland cement concrete (1 to 4) was deposited for a width of 11 feet and a depth of 4 feet, and on this the brick abutments are carried, giving a pressure of 2600 lbs. per square foot on the blue silt. The foundations for the approach walls were taken down to an average depth of about 4 feet into the blown sand overlying the peat, and were formed by steel reinforced Portland cement concrete (1 to 4), giving a maximum pressure of 1500 lbs. per square foot on the blown sand.

The steel work was designed to carry 60 tons on a wheel base of 10 feet by 5 feet, with a factor of safety of 5. The main girders are 60 feet clear span, and vary in depth from 5 feet 6 inches to 8 feet 6 inches. The cross-girders were specially designed to suit the excessive "skew" of the bridge—60 degrees —which is perhaps a record in obliquity. As a double line of tramways over the bridge had to be provided for, it was necessary also to specially design the cross-girders so as to obtain easy curves (in a vertical plane) over the bridge, and also at the lower ends of the approach gradients, which are 1 in 20.

11. Sewerage and Sewage Disposal.

It will have been already gathered, from the Section (No. 2) of this Paper, describing the physical features of the borough, that in consequence of the unusual peculiarity of a large part of the area of the borough draining inland from the sea in an easterly direction, the sewerage of the borough has been found to be by no means free from difficulties.

It has been found necessary to create three drainage areas to be served by pumping machinery (two steam and one gas), in order to raise the sewage up to the levels of the main sewers. Probably two more low-lying areas may have to be dealt with in the same way.

The sewerage is on the combined system, but, as far as possible, the natural watercourses have been utilized to take surface water.

There are about 90 miles of sewers, varying in size from 6-inch to 24-inch pipe sewers, and from brick barrels 2 feet diameter to storage sewers 13 feet 3 inches by 8 feet.

There are two main outfall sewers, both delivering into the sea below low-water mark of high spring tides. The main sewer outfall, as well as the surface water outlet, opposite Tyldesley Terrace, is made of 800 lineal yards of 3 feet internal diameter cast-iron pipes, each with an additional length of 150 lineal yards of 3-feet steel pipes, which were added last year to each outfall, so as to carry them into deep water.

There is an underground storm-water automatic electrical pump, of 107 B.H.P., opposite Tyldesley Terrace, by which storm water in the sewers is raised up to sea-level, when there is a combination of heavy rainfall and a high spring tide, as the level of the sewer outfall at Tyldesley Terrace is practically at O.D., and consequently is tide-locked to the extent of about 13 feet 9 inches at a high spring tide, so that many cellars would be flooded unless pumps were provided.

The northern outfall, opposite the Gynn, is also constructed of 3 feet diameter cast-iron pipes, about 450 lineal yards in length, and also delivers into deep water. The surface of the drainage area at the north end being much higher than at the central and south, no pumping is required, as the sewers are never tide-locked.

12. Refuse Destructor.

The first refuse destructor at Blackpool was an eight-cell plant, erected by Messrs. Manlove, Alliot, and Co., in 1891. Five years later four more cells were put down by Messrs. Horsfall and Co., giving a total capacity of about 88 tons per diem. The furnaces were top fed. Forced draught was obtained by means of two fans, driven by a horizontal engine, which also supplied power to a 5-feet mortar mill. Steam was generated by a small water-tube boiler, placed close to the cremator, which, fed by coke, assisted in destroying the offensive gases. The chimney was 120 feet in height and 4½ feet diameter. The buildings were of a temporary character, the roof above the tipping-deck being carried on cast-iron columns, the sides being filled in with timber boards.

In consequence of the phenomenal increase of both the resident and floating population of the borough, the plant described above had, of late years, come to be quite unable to cope with the summer refuse, which had to be stored in the open until the quieter winter months. This practice of storing refuse during the hot summer months was not only highly insanitary, but was also very expensive on account of the extra handling.

In 1902, therefore, the Corporation approved a scheme, prepared by the Author, for the entire reconstruction of the destructor, at a cost of 22,000*l.*

The scheme included a new furnace house and tipping-deck, 62 feet 5 inches by 48 feet, new boiler house, 34 feet 6 inches by 34 feet, and engine house, 34 feet 6 inches by 23 feet 6 inches, mortar mill shed, 49 feet by 19 feet, clinker crusher house, 28 feet 6 inches by 25 feet, lime store, new chimney, railway sidings, six new Horsfall cells, two new Babcock and Wilcox boilers, with engines, dynamos, motors, mortar mills, clinker crusher and screen, tin flatteners, etc. The buildings are faced with seconds Accrington semi-plastic bricks and terra-cotta dressings. The new chimney is 210 feet in height by 8 feet 6 inches internal diameter, built on the Alphons Custodis principle, with specially made perforated Ruabon bricks, and lined for its entire height with fire-brick, built in vertical sections of 20 feet, any one of which sections may be taken out and renewed without disturbing the other sections. The

foundations were carried down to the solid red clay, a depth of 23 feet 6 inches, and carried on a concrete base, 45 feet square by 6 feet deep. Cost of foundations, 999*l.*; cost of chimney above ground level, 1757*l.* Total, 2756*l.*

The new cells have a guaranteed capacity of 12 tons per cell per diem, which they much exceed in practice. The boilers develop 460 H.P. at a pressure of 120 lbs. per square inch, and the average temperature in the main flue is 1800° Fahr. when in full work. The power is converted into electrical energy by two dynamos, and is utilised for lighting, driving mortar mills, clinker crushers, saw mills, and all the machine tools and plant in the Highway Department, Rigby Road, closely adjoining the destructor. The Author desires to acknowledge the most efficient manner in which all the contractors carried out their work, and especially Messrs. Horsfall and Co., who were responsible for the details of the destructor plant proper.

13. Highway Depôts and Municipal Workshops.

For administrative purposes, the borough is divided into two highway districts, north and south, with separate foremen and staff of workmen, stores depôts, plant, timekeepers, storekeepers, etc., for each district, with sub-depôts at various points.

The northern district depôt is at Greenhill, off New Road.

The southern district depôt is at Rigby Road. Railway sidings from the lines of the Joint London and North Western and Lancashire and Yorkshire Railways are laid into each depôt. At Rigby Road are also the Corporation workshops, administered by the Highway Department, and executing work for other departments of the Corporation, including cement stores, saw mills, fitter's, blacksmith's, joiner's, cartwright's, painter's, and cement testing shops, all having machine tools driven by electricity supplied from the refuse destructor. Here are also the headquarters of the tramways permanent way, which is administered by the Highway Department.

14. Corporation Stables and Depôt.

Previous to 1902 the rapidly growing number of horses required in connection with Corporation work were stabled in a temporary and make-shift manner in various parts of the borough. This arrangement had both advantages and drawbacks, but it was felt, as the numbers increased, that greater economy of administration would be possible by concentrating all the teams at one point.

Consequently, in 1902–3, the present stables, capable of accommodating 60 horses, and including horse-keeper's house, 6 loose-boxes, hay, corn, and other storerooms, chopping, grinding, and hay-cutting rooms; electrically-driven machinery and electric light throughout, shedding on three sides of site for carts, etc., shoeing-smith's shop, veterinary surgeon's office, men's mess-room, water-troughs, weighing machine, etc., were built and equipped at a cost of 17,000*l.*, exclusive only of land. The cost of stabling proper worked out at the rate of about 70*l.* per horse.

15. Public Conveniences and Lavatories.

In consequence of the very large number of day-excursionists visiting Blackpool during the season, a comparatively large number of public conveniences have been erected in different parts of the borough within recent years.

There are four underground, two semi-underground (*i.e.* underground on three sides, but entered on the level on one side where levels were favourable), and one above-ground. The total accommodation provided is for 277 persons (male and female), at a total cost of 11,500*l.* The accommodation varies from 20 to 62 persons for each convenience, and the cost of erection from 973*l.* to 2394*l.* for each.

Although the charges are as small as possible, the gross revenue last year amounted to 2463*l.*, and, after paying all expenses, interest, and sinking fund, there was a net profit of about 300*l.*

The conveniences and lavatories are in all cases made internally of the best glazed ware, glazed bricks, and tiled or terazzo floors, with special arrangements for efficient ventilation.

16. Open Spaces.

The following open spaces are situate at various suitable places in the borough, viz.—

Locality.	Area in sq. yards.	Cost of forming and laying out.	Average annual cost of maintenance.	Remarks.
		£ s. d.	£ s. d.	
King Street and Cookson Street	250	69 11 1	9 9 4	
Central Drive and Central Road ...	820	103 12 6	9 6 10	Planted with trees which have since been removed. Maintenance cost will increase to about £25.
Whitegate Drive and Raikes Road ...	200	22 17 6	5 15 11	Trees. No grass.
Raikes Road at Secondary School ...	954	127 15 2	28 12 6	
Regent Square ...	232	83 2 4	9 0 0	Completed in 1907.
Church Street at St. John's Church ...	398	Annual rent 6 0 8	5 4 2	Few flower beds.
Gynn Estate... ...	3414	Not yet laid out		
Claremont Road ...	7063	" "		

17. Sea-Water Supply Works.

The Sea-Water Supply Works were originally constructed by a private owner, under the powers of the Blackpool Sea-Water Act, 1873, from whom they were purchased by the Corporation in 1903.

They consist of a 10-inch cast-iron intake pipe and supply tank built on the foreshore opposite the pumping station, from which the sea-water is drawn through 216 lineal yards of 10-inch cast-iron suction pipes, laid in a 4-feet diameter culvert, to the bottom of the pump well, at a depth of 69 feet 6 inches below the ground level. From this level the water is lifted, by means of two horizontal steam geared pumps, each about 20 B.H.P., to a height of 61 feet above ground level, or a total height of 130 feet 6 inches, into a cast-iron tank, 61,300 gallons capacity, at an elevation of 141 feet above O.D. A low-level tank, 73,500 gallons capacity, is placed just under the ground level for storage purposes between tides.

The pumps are of the bucket type, 15½ inches in diameter and 3-feet stroke, fixed at the bottom of the well, with long spear rods working off the engine-cranks, 80 feet above. Steam is supplied by a Lancashire boiler, 24 feet by 7 feet, at a pressure of 70 lbs. per square inch.

Sea-water is supplied to the principal hotels and boarding houses, as far as South Shore, through about 5700 lineal yards of distributing mains, from 2 inches to 9 inches diameter. Sea-water is also used to a great extent by the Corporation for street watering, sewer flushing, and other public purposes.

The total capacity of the plant, working during practicable tidal hours, is about 200,000 gallons per diem.

18. Sanatorium Extensions.

The sanatorium was originally erected in 1891 from designs by Mr. J. Wolstenholme, then Borough Surveyor, on a plot of land about four acres in area costing 1700*l.*; buildings, equipment, and laying out grounds cost 6675*l.*, or a total of 8375*l.*, and included two ward blocks for 20 beds and 4 cots, administrative block, disinfecting and laundry block, and a stable. A porter's lodge was erected in 1898.

Large additions were made in 1905–6, from plans prepared by the Author, including additions to administrative block, new disinfecting and laundry block, boiler house, 10-bed double isolation block, and a 22-bed double ward pavilion, giving an additional 32 beds accommodation, at a cost of 17,052*l.*, including all buildings and equipment, or at the rate of 533*l.* per bed. The present total accommodation is therefore 54 beds and 4 cots, at a total cost of 25,427*l.*, or at the rate of about 462*l.* per bed, and counting two cots equal to one bed, including land. Provision is made for a future extension, if necessary, of an additional 22 beds, on the present land.

The floors are of narrow teak planks throughout, finished with Ronuk; the walls are finished internally in Keene's cement and Ripolin paint, and externally of best plastic Accrington bricks and stone facings.

The heating is by hot water, with calorifiers for each block, supplied with steam from two Lancashire boilers, one 27 feet by 7 feet, and one 15 feet by 5 feet 6 inches. Hot-water pipes

run under all floors, and wards are heated by radiators. The ventilation is by the ordinary turret ventilators, assisted by heated-air inlet stoves and grates.

19. Two New Council Schools.

The late Blackpool School Board and, since 1902, the Council, as the local Education Authority, have, during the past nine years, erected five new elementary schools and one secondary school. Three of the elementary schools were erected from competitive designs at a cost of 60,300*l.*, exclusive of land, and an accommodation for 3179 scholars, equal to a rate of 18*l.* 19*s.* 2*d.* per scholar.

Two schools were erected last year, from plans prepared by the Author, at a cost of 16,522*l.*, exclusive of land, but including full equipment, and an accommodation for 1080 scholars, equal to a rate of 15*l.* 5*s.* per scholar.

The secondary school cost 20,597*l.*, and has accommodation for 400 students, or a cost of 51*l.* 10*s.* per student.

The designs for the two latter (Claremont and Waterloo Road) schools provide for mixed and infant departments (900 each school), but the mixed departments only (540 each school) are at present erected, so that the cost per scholar will be considerably reduced on completion.

Both schools are single storey, with classrooms 24 feet 4 inches by 24 feet 8 inches (each 60 scholars) grouped round a central hall 81 feet 3 inches by 30 feet. Heating is by hot water, with pipes and radiators. Ventilation is natural, with outlets in ceilings connected to turret extractors. Fresh air brought to central hall and classrooms by means of 24-inch glazed stoneware pipes, with ducts under floors, and branches are run to screens which are provided with hit-and-miss aluminium grids. Walls are internally of high-glazed brick dados and plaster above, with Accrington plastic bricks and stone dressings externally. Central halls and classrooms have wood-block floorings, and entrance halls and cloak-rooms have granolithic concrete floors.

20. Allotments.

In 1903 the Corporation laid out a portion of their surplus lands on the easterly and westerly sides of Central Drive as allotment gardens. The gardens were very quickly tenanted, and have been much appreciated by most of the holders. A healthy spirit of rivalry is in existence, as is evidenced at the Annual Allotment-holders' Show. The contents of the land so laid out is about 10½ acres, divided into 65 allotment gardens. The number of tenants is 63, and the whole of the gardens are tenanted. The gardens vary in size from 482 square yards to 653 square yards, and the rents—based, of course, on the size of the plots—run from 17*s.* 9*d.* per annum to 1*l.* 7*s.* 1*d.* per annum. The rent paid clears the tenant, the Corporation paying any rates, and also the water charges.

The Corporation have appointed one of the tenants of an allotment on the easterly side of the Drive, and also a tenant on the westerly side of the Drive, as respective superintendents of the gardens on either side, and these superintendents, in return for an allowance from their rent, see that the regulations are duly observed.

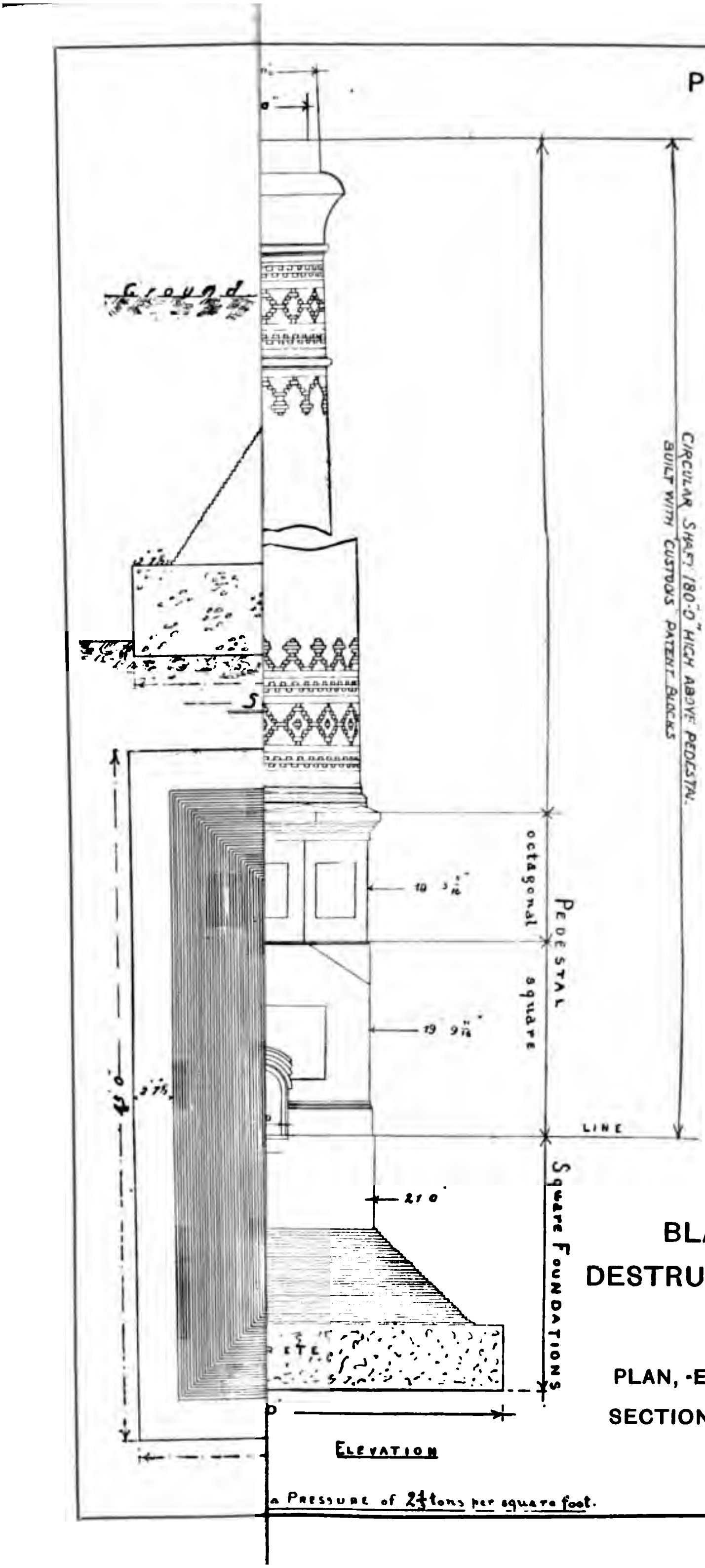
21. Corporation Estate.

The Corporation Estate, 26 acres in extent, costing 13,250*l.*, at the Gynn, in the most northerly part of the borough, was purchased in 1897 for the purpose of providing filling material in connection with the North Shore Sea Defence Works and Promenades. Since the completion of these works, the estate has been, and is being, gradually sold off for building plots.

The Corporation also possess limited areas of land in various parts of the borough, which are really surplus land left after the street improvements have been effected in connection with which they were purchased.

A further estate, adjoining the Gynn Estate, of an area of 26½ acres, has recently been purchased by the Corporation at a cost of 5100*l.*, also with a view to a very extensive contemplated street improvement and town planning scheme.

PLATE NO. 1.



BLACKPOOL
DESTRUCTOR WORKS.

PLAN, ELEVATIONS AND SECTIONS OF CHIMNEY,

[*To face p.* 224.

22. Public Mortuary.

The public mortuary was erected in 1903, from plans by the Author, on land belonging to the Corporation adjacent to the cemetery.

It consists of a mortuary chamber 24 feet by 16 feet 6 inches, fitted with six blue slate slabs each 6 feet 8 inches by 2 feet 6 inches by $1\frac{5}{8}$ inch thick, built up 3 feet above the floor level on buff glazed brick piers; a post-mortem chamber 15 feet by 16 feet 6 inches, fitted with special operating table of porcelain enamelled fireclay, with overflow to porcelain channel formed in concrete floor and leading to outside gulley; juries' viewing corridor, storeroom, w.c.; and lavatory accommodation, with hot and cold water.

The floors are of cement concrete, finished smooth, with falls to channels.

The interior walls of rooms are lined with buff glazed bricks. The mortuary and public mortuary rooms are lighted from the roof, the lights having a northern aspect. The ventilation is natural, by means of extra large louvres, protected by finely perforated zinc fly-guards.

The exterior of the building is of best selected local bricks, with blue brick dressings and York stone heads and sills.

The total cost of erection and equipment of the building, exclusive of land, was 666*l.*

23. Cemetery Extensions.

The Blackpool Cemetery is the property of the Corporation (who are the Burial Board for the district), and was originally 8 acres in extent, and was laid out in 1872–3.

In 1899, by a clause in an Improvement Act, the Corporation were authorised to acquire compulsorily a further area of 25 acres for cemetery extensions, contiguous to and on the north side of the old cemetery. This land was acquired by arbitration in 1901, at a cost of 7382*l.*

In 1905–6 a provisional extension of $3\frac{1}{2}$ acres was made, at a cost of 2458*l.*, which included main drainage (average depth 17 feet), deep sub-soil drains (14 feet below the surface), surface water drains (3 feet in depth), laying out walks, levelling, fencing, and planting with trees.

The deep sub-soil drains were laid on an average 30 feet apart, and the average nature of the sub-soil was—7 feet boulder clay, 1 foot running sand, 3 feet of marl, 3 feet of wet loam.

The roads were formed of 9 inches of hard burnt clinker, covered with 6 inches of Carnforth gravel well rolled, with all necessary manholes, surface water gullies, etc.

24. Building Bye-laws: New Buildings.

The following tabulated return shows the number of new dwelling-houses and temporary and movable buildings, as well as the lengths of new streets, sewers, and house drains inspected and certified under the Bye-laws and Local Acts:—

Years.	New Dwelling Houses. No.	New Streets. Miles.	New Sewers. Miles.	House Drains. Miles.	Temporary and movable Buildings. No.
1901	370	3	2½	5	
1902	883	4¾	3	3	6
1903	311	5	3	3¼	34
1904	292	2½	2½	3¼	48
1905	245	2¾	2¼	2¾	47
1906	318	2¼	1¾	5½	67
1907	295	3	3	4¾	93
	2214	23¼	18	27	295

25. Water Supply.

The water supply, which is of an abundant and most excellent quality, is by gravitation from impounding reservoirs at Barnacre and Grizedale Moor, a distance of 18 miles from Blackpool.

The Fylde Water Works, which were originally the property of the Fylde Water Company, were opened in 1865. The works were acquired by the present Board under Statutory Powers in 1899.

The Fylde Water Board consists of fifteen members, nominated by the Corporation of Blackpool (7); the Urban District Councils of Fleetwood and Lytham (each 3); and the Urban District Council of St. Annes-on-the-Sea (2). The Board supplies water to practically the whole of the Fylde and

Garstang Districts. Mr. William Wearing is the engineer to the Board.

The present capital outlay of the Board stands at 1,133,753*l.*

The rate of annual charges for domestic supply varies from 1*s.* 1¼*d.* to 1*s.* 6*d.* in the £, including one free W.C. The supply by meter for trade purposes, other than domestic, ranges from 9*d.* to 1*s.* 6*d.* per 1000 gallons.

26. Gas Works.

The Gas Works, originally started by a Company in 1852, were purchased by the Corporation in 1861, and have cost a capital outlay of about 210,700*l.*

The total quantity of gas made last year was 531 million cubic feet, yielding a net profit of 15,700*l.*

There are about 89½ miles of gas mains, 2170 street gas-lamps, and 13,623 private consumers.

The price per 1000 cubic feet for lighting purposes is, and has been for many years, at the rate of 2*s.* 4*d.*, while for power purposes, when taking a maximum of 50,000 cubic feet per quarter, the price is reduced to 1*s.* 10*d.* per 1000 cubic feet.

The total profits from the Gas Works made since the undertaking was acquired by the Corporation amount to 257,700*l.*, or considerably more than the capital cost of the works.

The gas manager is Mr. John Chew, to whose skill and ability the extremely efficient and commercially prosperous condition of the gas undertaking is due.

27. Electricity Works.

The Corporation Electricity Works were originally constructed under statutory powers, and opened in 1893. They have been much extended since, until the capital outlay now stands at about 190,000*l.*

The system of supply is both direct and alternating, with a standard voltage of 200, and the works now contain 14 engines, with a total indicated horse-power of 4825. These are supplied with steam from 12 boilers, each with a pressure of 140 lbs. per square inch. There is a storage battery of 260 cells, and a cooling tower of 250,000 gallons per hour capacity.

The units supplied last year were 2,899,204, including lighting and power (1,232,932), public lighting (282,251), and tramways (1,384,021), yielding a net profit of 8299*l.* There are 1108 consumers, 99½ miles of electric lighting mains, 277 public arc lamps, and 706 public incandescent and Nernst lamps.

The charges for lighting are on the maximum demand system (6*d.* for first hour and 2*d.* afterwards), or, alternatively, a flat rate of 5*d.* per B.T.U.; for power purposes, 3*d.* for first hour and 1*d.* afterwards, modified by a sliding scale based on quantity taken.

The borough electrical engineer is Mr. Charles Furness, by whose energy and professional skill the Electric Light Undertaking has been placed on a thoroughly satisfactory profit-earning basis.

28. TRAMWAYS.

The Blackpool Tramways were the first electrically operated street tramways to be installed in the United Kingdom, and were laid down by the Blackpool Tramway Company, from a Scheme prepared and carried into execution by Mr. J. Wolstenholme, C.E., then borough surveyor, as regards permanent-way, and Mr. Holroyd Smith in respect of electrical details, and opened by the late Alderman Sir J. H. Harwood, of Manchester, on September 29, 1885.

The gauge is 4 feet 8½ inches, and the central slot, with underground conductor system, was adopted, current being supplied from a generating station at 200 volts continuous.

The Tramway Undertaking was purchased by the Corporation from the Company in 1892.

Probably no more unfortunate situation could have been chosen for central slot electrical traction than Blackpool Promenade in 1885, with its frequent sandstorms, floodings at high tides, etc., now, happily, experiences of the past.

In 1899 it was therefore decided to replace the central slot underground system by the overhead trolley method of traction, at 500 volts potential, and this work was successfully carried out by the late Mr. R. C. Quin, then borough electrical engineer.

The length of permanent-way (which is in charge of the

Highway Department) now in use within the borough is as follows:—

2 miles	1 furlong	9·56 chains	of 6-inch rails	(92 lbs.)	laid in	1895.
6 „	6 „	9·40 „	„ 4½-inch „	(98 „)	„	1900–01.
12 „	1 „	4·71 „	„ 7-inch „	(98 „)	laid since	1900.
Total 21 miles	1 furlong	9·67 chains.				

The electricity is supplied from the Corporation electricity works, at a rate of 1·79*d.* per unit.

The tramway capital outlay stands at 281,390*l.*, and the net surplus last year was 10,042*l.*

Of the above length of single-line track, 17 miles 3 furlongs 0·7 chains are owned and operated by the Corporation, while 3 miles 6 furlongs 8·97 chains are owned by the Corporation, but are worked by the Blackpool and Fleetwood Tramroad Company, Ltd., on the north side, and by the Blackpool, St. Annes and Lytham Tramway Company, Limited, on the south side of the borough.

The tramway department has, from the very first, been most successfully administered by the present able general manager, Mr. John Lancaster, to whom great credit is due, both for its efficient condition and successful commercial position.

29. Street Lighting.

The Street Lighting of the borough is in charge of a principal Committee of the Council called the Markets and Street Lighting Committee, and as regards the gas lighting, is under the immediate direction of the gas manager, while the public electric lamps are under the management of the borough electrical engineer, both of these departmental officers working under the directions of the above Committee, so far as regards public lighting.

There are 2100 public gas lamp posts lighted, at a cost of 5423*l.* per annum; and 1083 public arc, Nernst, and incandescent electric lamps lighted, at a cost of 5863*l.*, or a total cost of street lighting of 11,286*l.*, per annum.

30. Street Cleansing and Refuse Removal.

The cleansing and watering of streets, and also the removal of house refuse, are in charge of a principal Committee of the

Council, with a Cleansing Superintendent and staff. This department is also responsible for the working of the refuse destructor, sewer cleansing and flushing, the supervision of all the public sanitary conveniences, and other similar duties.

31. Town Hall.

The Town Hall was commenced in 1895, and completed in 1900, at a cost of 81,500*l.*, including cost of site and furnishing, from competitive designs, that of Messrs. Potts, Son, and Hennings, architects, being successful.

The façades are of Ruabon bricks and Yorkshire stone. Facing Talbot Square, over the main entrance is a Clock Tower and steel and timber composite spire, covered with sheet copper, 180 feet in height.

The ground floor accommodates the Borough Treasurer and his staff, the Borough Surveyor and part of his staff, and the Advertising Manager and his staff, while part of it is let off in shops. The first floor is occupied by the Council Chamber, Mayor's parlour, Committee-rooms, and Town Clerk's department. The second floor contains the Borough Surveyor's drawing offices and wages clerks' offices, and the caretaker's apartment.

The Town Hall Buildings are already inadequate to meet the growing requirements of the borough, as the Medical Officer's, Cleansing Superintendent's, and Education's departments are all located in rented premises in different parts of the town.

32. Police Courts and Stations.

The Police Courts, South King Street, were erected in 1892, at a cost of 20,560*l.*, from plans prepared by Mr. J. Wolstenholme, C.E., then borough surveyor.

There are two courts, a Coroner's room, Justices' consultation and retiring rooms, Chief Constable's residence, with all necessary offices, cells, married and single men's quarters, men's recreation-room, parade ground, etc.

The exterior of the courts is of York stone parpoints and Rainhill stone dressings.

There are two sub-district police stations in different parts of the borough, and the erection of another is now about to be proceeded with.

33. Fire Brigade Depôt.

The Fire Brigade Depôt was erected in 1900, at a cost of £9288, from plans, etc., prepared by Mr. J. A. Nuttall, architect, Blackpool.

The depôt includes a large fire-engine room, containing:—

One steam engine, 400 gallons capacity.
One manual do.
One two-horse chemical carrier and escape combined.
One 45 feet hand escape.
One cart hose.

Stabling containing four horses, offices, Superintendent's residence, Firemen's quarters and recreation-room, and the Gamewall Fire-alarm apparatus, and all the most up-to-date appliances for attending to calls with the utmost celerity.

34. Wholesale Market.

The Corporation Wholesale Fruit and Vegetable Market is situated in Market Street, and was originally erected in 1854. Plans prepared by the Author are now under consideration for the entire re-construction of the Market Buildings, at an estimated cost of 45,000*l.*

35. Public Slaughterhouse.

The Public Slaughterhouse, off New Road, was erected in 1895, from plans, etc., prepared by Mr. J. Wolstenholme, then borough surveyor, at a cost of about 14,000*l.* They are substantially built, and are closely adjacent to the main lines of the railway companies. Facilities are provided for the annual slaughter and dressing of about 4000 cattle, 40,000 sheep, and 2000 pigs.

36. Public Libraries and Reading Rooms.

The Central Public Library was established in 1880, and at present occupies temporary premises belonging to the Corporation in Market Street. There is also in the same building the nucleus of a future Art Gallery. A scheme is, however, now

under consideration for entirely new and more commodious Central Library Buildings and Art Galleries.

There are also three branch Reading Rooms and Lending Libraries at suitable points in the borough, while in connection with the branch Reading Rooms at Revoe, recently erected, a Gymnasium has been built and equipped.

DISCUSSION.

MR. T. W. A. HAYWARD: It is gratifying to see that the Corporation, although they have the public spirit and enthusiasm to embark on such expensive schemes, are doing it on the comparatively low rate of 5*s*. 6*d*. in the pound. I am glad to see you have adopted the principle of wide streets, and that you are paving your streets with impervious material. You are justified in so doing when your death rate is only 11 per thousand, which speaks volumes for the town of Blackpool. I think Mr. Brodie is to be heartily congratulated upon the success of the sea defence works.

MR. E. WILLIS: Mr. Brodie does not mention the cost per ton of house refuse consumed. And with regard to tree planting, might we know if the soil has been found unsuitable for planes, acacias, and chestnuts, as each of these have a very good appearance, and are fairly hardy.

In the section dealing with new buildings, mention is made of temporary or movable structures approved by the Council. I should be glad to know if you have special clauses dealing with temporary structures, and whether fees are paid for licenses or supervision, and the time such buildings are allowed to remain, whether indefinitely or from year to year. Could Mr. Brodie inform us if the two-horse chemical fire-engine and combined escape has yet had much work to do, and if so, whether it has been an absolute success. Some of the prices mentioned by Mr. Brodie seem abnormally cheap in comparison with those current in or near London. Would he give some idea as to the value of labour in this locality.

MR. G. W. LACEY: According to the bye-laws, I observe that the minimum width of ordinary front streets is 36 feet. The paper states that main thoroughfares are from 45 feet to 60 feet wide, and I should like to ask if there is any difficulty

in getting owners to lay out now streets of a greater width than 36 feet. The average cost of streets 36 feet in width is given in the paper at 8*l.* 1*s.* 10*d.* per lineal yard, or equal to 10*s.* 3*d.* per foot frontage, which includes, I presume, carriageways of macadam, and on this point I should like to ask what is the difference between this and the works given in the summary statement. I take it that a certain amount of work has been done on the new streets, and that the cost in the schedule is for the completion, whatever that may include, as the rate per foot of frontage for 1907–1908 works out at 8*s.* 4*d.* Another point is whether back streets are required in connection with all the front streets. I should like to know, seeing that the water supply is a moorland supply, whether it is subject to peaty discoloration, and whether the water is filtered. The charges would appear to be rather high. Respecting the street lighting by gas, the cost of which works out at 2*l.* 11*s.* 8*d.* per lamp per annum, the information does not state whether the burners are incandescent or the ordinary flat flame.

MR. A. J. PRICE: I think one should remember, when you look at the plans of the sea wall, that this is the largest undertaking of the kind in this country, and that Mr. Brodie was not only responsible for the design of it, but also for the carrying out of the work.

I do not think the work is quite as ornamental as Mr. Brodie would have liked to make it, but considerations of economy come in, and therefore one is not able to do all one likes as to ornamentation, but with regard to the structure, its strength and stability, I do not think there can be any question. It was proposed to widen the promenade 60 feet originally, but afterwards Mr. Brodie was able to get his way and widen to 100 feet by showing the Council that it was only a question of filling in more sand, and that the wall would be the same cost in either case. There are one or two regrettable features. At the pier it is badly contracted, being only 60 feet wide. It rather spoils the use of the promenade there, and it seems to me a great pity that the pier companies stood in the way of making the whole promenade the same width throughout. At the North Pier there is a return concrete wall abruptly ending the promenade.

The intention, I believe, of Mr. Brodie was to take the sea wall across the bay and utilise the space enclosed for sea-water

baths, and it is unfortunate that he could not carry this scheme out. The return wall had to be made of great strength to withstand the force of the waves, and if the sea-wall had been extended across the bay, this wall would not have been required, or it would not have been needed so strong as it is now. I am sorry Mr. Brodie was not permitted to finish this work, but seeing that money is becoming easier—the bank rate is going down—the Council may shortly be able to allow him to finish the promenade. With regard to the widening, I think you must all agree that the way in which the promenades, tramways, and roadway have been laid out is a very good arrangement. Mr. Brodie thinks limestone is the best material for tar macadam, but I think granite would be much better on the grounds of economy, durability, and absence of dust. Limestone is too soft a material for a roadway with the traffic you get on the sea-front at Blackpool. I have treated the road along the sea-front at Lytham with tar and granite chippings, and during the whole of last year I never had a watering cart on the road, though forty or fifty motor cars sometimes pass over it in an hour. When granite has been put down properly you have a more durable roadway, and you have got rid of the dust nuisance. I have recently been speaking to a man who has a good deal to do with horses, and who said to me, "You will always get broken-winded horses on limestone roads because of the dust." Turning to the prices given in the paper for different kinds of paving, one wonders how some of the work has been done. I do not know how Mr. Brodie has been able to get Haslingden setts 6 inches deep laid on a 7-inch hand-pitched foundation for 6*s.* 6*d.* per yard. The price for the hardwood blocks is a reasonable one. The ordinary macadam roadway, with 5 inches of Penmaenmawr granite on 7 inches of hand-packed rubble, is given at 3*s.* 9*d.* per square yard, and this is a very reasonable price. Then we have tar macadam, 5 inches thick, on 8-inch hand-packed rubble at 5*s.* 9*d.* per yard, and this seems very high. I take it this price is for the front, where there are special features. I do not think tar macadam should cost more than 1*s.* per yard more than ordinary macadam. With regard to the planting of trees in the streets at Blackpool, I think the difficulty of doing this is over-estimated. Although Mr. Brodie says they have great difficulty in growing trees on the front, I think he will be able to do so if his Council will

give him the necessary time and money. Blackpool prides itself on being up-to-date, but the absence of trees is the penalty of its modernity, and time and money must be freely spent before it can look for any great improvement in this respect.

Mr. R. P. Hirst: It must be a satisfaction to Mr. Brodie, as it must be to the Corporation, that in the promenade extension he has been able to carry out the work within the estimate, though he has made the promenade 100 feet wide instead of the 60 feet originally proposed. That is due very largely to the work being carried out by Mr. Brodie himself without the intervention of a contractor. I cannot agree with Mr. Price that the difference in the cost of a tar macadam road and an ordinary macadam road should be so slight as he estimates. With regard to the soft wood paving, I cannot understand how Mr. Brodie can do that on a 6-inch concrete foundation for 6*s.* 1½*d.* per square yard. With regard to the cost of streets given under the heading Private Street Works—summary statement—does that include the cost of the main sewer? In a previous paragraph Mr. Brodie says the average cost per lineal yard of streets, including carriageways, footpaths, gulleys, connections, and underdrainage (but not sewers), is for streets 36 feet in width, 3*l.* 1*s.* 10*d.* per lineal yard. Working that out, it appears as though the sewers are also excluded from the summary statement, but I should like to know whether that is so, and why. With regard to tree planting, I think they have made an admirable start in Blackpool. It is one of the things which Blackpool requires, but an outlay of 2*l.* per tree seems a rather large item. In Southport we can do it on an average at about 15*s.* per tree, and we have planted some thousands of trees. The question of allotments, though only a small thing at the beginning, is one of very great importance, which we shall have to pay more attention to.

Mr. J. Johnson: I should like to ask Mr. Brodie whether his price for paving includes the racking of the setts with granite chippings and running with pitch, also what his experience is of County Clare flags, which I understand he has used, and the price of same, as they are not included. I notice that his price for Lancashire flagging is 4*s.* 11*d.* per yard, and I think there must be some mistake with regard to this, as I am in the midst of the Lancashire flag quarries and have to pay nearly that price

for best barns flags without squaring or laying. I would like to know the reason that the cost of Private Street Works in the years 1901–1902 given is so much more than the other years. I think if we had the number of hours in the year that the street lamps are lighted it would be a useful addition to that part of the paper.

MR. T. S. PICTON: The sea defence works are without doubt a splendid example of engineering skill. In the paving of the footpaths of Blackpool a great quantity of Lancashire and Yorks natural flags have been used. I strongly advocate the use of 2½-inch concrete flags. They are cheaper than the natural flags, and will give better results: they do not laminate; and they have no holes in them. I think it is proved conclusively by the use of concrete flags on London bridge as compared with Yorkshire flags on the Thames embankment. I also think the smaller flags give the best results. I am glad to see the Corporation are taking action as to providing allotment gardens. I am pleased also to see that the repair and maintenance of the tramway track is under the control of the borough engineer, and not the tramway manager. I find there is no mention made in the paper of a public bowling green or public swimming baths. I take it that the Corporation of Blackpool allow private enterprise to make such provision.

MR. W. H. GRIEVES: I have pleasure in proposing a hearty vote of thanks to the Author. I should like to have heard more of the tar spraying results, which I think our President could enlighten us on. The tar spraying Mr. Price did at Lytham, was, I believe, on granite and not granite tar macadam.

MR. PRICE: But I have some granite tar macadam.

MR. GRIEVES: I have not yet heard of any very satisfactory results of granite tar macadam. I admit that limestone tar macadam may be dusty at times, but that may not be the result altogether of the material. Dust is also caused by horse-droppings and other things on the roads. As to Mr. Price's allegation about broken-winded horses on limestone roads, I have been in Buxton twelve years, we have nothing but limestone roads, and I have never heard of a broken-winded horse. I should, however, like to have heard something about dustless roads, had there been time. I should also like to hear something as to how the administrative work is carried on, and how you get on with the Local Government Board when the work is

done by regular men employed by the Council. With regard to the use of 2½-inch concrete flags, I suggest that you should go in for 3-inch flags, as they are much better than 2½-inch.

MR. W. JONES: I desire to compliment Mr. Brodie on the nature of the material he has used in his sea wall. In the two and half miles of promenade which I have carried out at Colwyn Bay, I have unfortunately been obliged to use local limestone, and the same durability cannot be expected from that material. I beg to second the vote of thanks to Mr. Brodie.

Mr. W. B. CHANCELLOR: Municipal engineers in the Midlands are seriously troubled with the dust problem. In Lichfield as many as 400 motor cars pass through daily. I have been trying tar painting the road surfaces and find that it answers fairly well during the summer months, but that during the winter a nasty greasy mud is created, very difficult to remove, and that the second state of the road is really worse than in the first instance. I should be glad if the Borough Surveyor of Blackpool would inform me whether the whole of the tar macadam in Blackpool is of limestone, or whether he has laid down any of slag or granite, also which of the materials he finds to be the best. We know that limestone in itself is a soft material, and I cannot quite see why, when incorporated with tar and other ingredients, it should be made preferable to, say, granite tarred macadam. There has hitherto been a difficulty in forming a suitable matrix to bind granite together, but, providing that difficulty is removed, I venture to submit we have discovered the road of the future. Respecting the cost of laying down tarred macadam I find that it can be done in Lichfield for 3*s.* 9*d.* per super yard, *i.e.* 8 inches of slag pitching and 4 inches granite tar macadam topping. Limestone tar paving on footways in side streets 2 inches thick, including foundations, can be executed at 1*s.* 6*d.* per sup. yard.

COMMUNICATED REPLY.

MR. J. S. BRODIE: In reply to Mr. Willis. The cost per ton of collecting and destroying the house refuse at the destructor is about 1*s.* 5*d.* Planes and chestnuts have been planted in some of the streets before the Author's time, and, where

sheltered from the prevailing winds, have been successful; in exposed situations, they have not been so. The standard rate of wages applicable to the district is, in all cases, paid. Temporary and movable buildings are regulated by a local act, Blackpool Improvement Act, 1901, section 46, but no fees are collected by the corporation or the staff. The fire escape and chemical carrier answer all the purposes which were expected from them.

In reply to Mr. Lacey. Back streets may be required by the corporation 12 feet in width, under the Blackpool Improvement Act, 1893, section 68, and are nearly always insisted upon. The water supply is not from a peaty sub-soil at all, and is never discoloured, and although mechanically filtered, might very well be supplied without filtration at all. Street gas lamps are almost entirely fitted with incandescent mantles, but a few flat flame burners are still in use in back streets.

In reply to Mr. Price. The prices stated in the paper, namely 6*s.* 6*d.* per square yard for Haslingden setts, and 6*s.* 1½*d.* for soft wood uncreosoted blocks, are perfectly correct.

In reply to Mr. Hirst. The price for tree planting given in the paper, 2*l.* 0*s.* 7*d.* per tree, includes the tree itself, planting, the grating, and wire guard round the tree, under-drainage, and all complete, whereas the 15*s.* referred to by Mr. Hirst refers to the tree and its planting only.

In reply to Mr. Johnson. The higher cost for private street works of 1901–1902 over the following years, was in consequence of the standard specifications being somewhat modified in the latter period.

In reply to Mr. Picton. Concrete flags have been extensively tried in Blackpool, and have not been a success. They are found to be quite unable to resist the action of frost, and are especially liable to be broken in connection with re-laying gas, electric light, and water main trenches. There are no corporation bowling greens nor swimming baths at Blackpool.

In reply to Mr. Grieves. The same difficulty is experienced at Blackpool as elsewhere in regard to the views of the Local Government Board as to the employment of the permanent staff on works carried out under loan.

In reply to Mr. Chancellor. The Author has had experience in the use both of slag, limestone, and granite, but, as the general result of such experience, he finds limestone on the

whole most suitable to work with in respect of tar asphalte macadam. He is, however, still experimenting in regard to the use of granite for that purpose.

The President and Members attending the Meeting were entertained to luncheon by the Mayor of Blackpool at the Hotel Metropole. The Mayor (Alderman Battersby) occupied the chair.

The afternoon was occupied by the inspection of the sea defence works and promenades, tar asphalted carriage-ways, wood paved carriage-ways, the main sewer outfall, refuse destructor, highways, depôts, and municipal workshops, corporation stables, sea-water supply works, sanatorium extension, electricity works, fire brigade depôt, and the garden city at Cleveleys.

SCOTTISH DISTRICT MEETING.

June 19 and 20, 1908.

Held at Dunoon.

J. Lee, Burgh Surveyor, Paisley, *in the Chair*

The Members assembled in the Burgh Chambers, where they were received and very heartily welcomed by Provost Dobré, on behalf of the Town Council.

The Chairman thanked the Provost for his very kind welcome.

Bye-Laws.

Mr. Bryce reported that the Burgh Officials had revised the bye-laws, and the Committee having made some further revision had again sent them on to the Burgh Officials Association. A meeting of the District would be called, and when the bye-laws were finally adopted they would be sent to the Local Government Board for their approval, and it is hoped that would be done in the coming autumn.

Mr. Bryce was unanimously re-elected Honorary District Secretary.

MUNICIPAL ENGINEERING WORKS AT DUNOON, WITH SPECIAL REFERENCE TO THE WORKING OF MECHANICAL FILTERS.

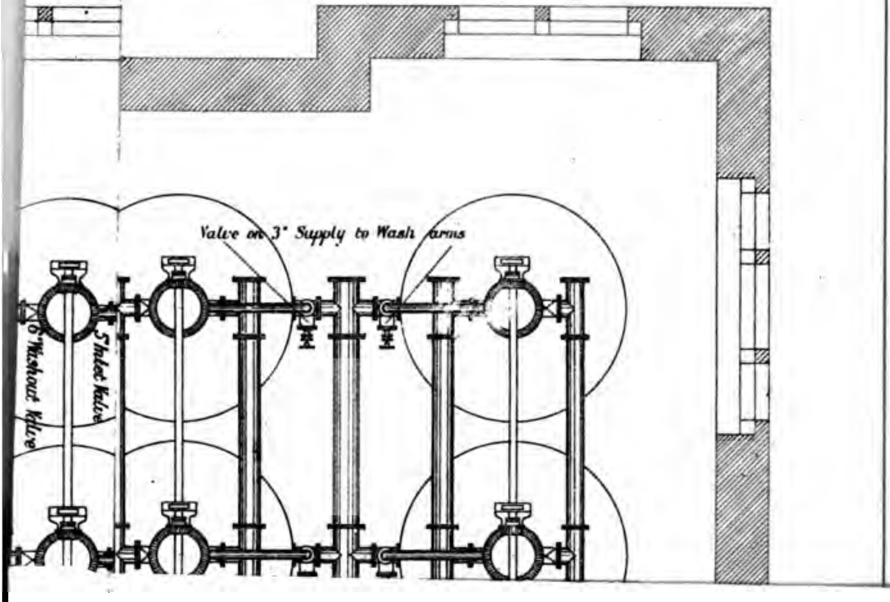
By JAMES ANDREW, Burgh Surveyor, Dunoon.

Introductory.

Dunoon is situated on the west shore of the Firth of Clyde, where the tidal wave at ordinary spring tides is 11 feet.

The burgh has a sea-front of 3 miles, on which there are

PLATE No 1



ONS, 13 BARTLETTS BUILDINGS, HOLBORN CIRCUS. E C

three piers, Dunoon, Kirn, and Hunter's Quay. Dunoon Pier is the property of the Town Council, and along with the Pavilion, Castle Gardens, and the natural setting behind makes a very pleasing impression on the visitor.

Dunoon was constituted a burgh in 1868, and in the forty years of its burghal existence it has evolved from a seaside resort for the classes to a popular holiday resort for the masses.

The following paragraph shows the valuation for the past thirty years, and gives the principal events municipally for the same period. From it also can be gathered sufficient of general interest to make further introductory remarks unnecessary.

In 1878 the rateable value stood at 36,000*l.*, rising to 42,000*l.* in 1882. In 1891, when the burgh boundaries were extended, the rateable value reached 45,000*l.* In 1893 Dunoon Castle House and Gardens were purchased at a cost of 4600*l.*, the rateable value standing at 46,000*l.* In 1895 the burgh was divided into wards. 1896 saw the purchase of the Dunoon Pier from the Hafton Trustees at a cost of 27,000*l.*, the rateable value having then risen to 53,000*l.* In 1898 the pier, extended and enlarged, was opened, the cost being 26,500*l.*, including buildings. The rateable value at this date stood at 58,000*l.* In 1900 the gas works were taken over from the gas company at a cost of 31,060*l.*, rateable value 64,500*l.* In 1902 mechanical filters were introduced. In 1905 the pavilion was built at a cost of 16,000*l.*, rateable value 72,500*l.* 1906 saw the opening of the new Front Road and Shore Road widening, cost 38,000*l.* The rateable value in 1908 stands at 77,000*l.*

WATER SUPPLY.

To describe the various schemes from among which the present source of supply was selected as the most suitable, and to go into the arguments for preferring the selected one and discarding the others, would provide good subject matter for discussion, but it would occupy too much time, and consequently only the water supply and works as they are to-day will be dealt with.

The drainage area, 1100 acres in extent, is moorland, and provides pasturing for sheep. It is, unfortunately, lined with sheep drains, and these allow the water to flow off rapidly, producing a twofold effect, the reverse of beneficial.

The raw water passing over peaty lands and cutting its way through mossy sheep drains, arrives at the reservoir at certain seasons of the year very much discoloured.

At other times the raw water is quite normal as regards colour.

The storage capacity of the reservoir above the lowest outlet is 90,000,000 gallons, equal to approximately three months' supply at the time of greatest consumpt.

The top water area of the reservoir is $10\frac{3}{4}$ acres, and the top water-level is 242 O.D.

The outlet from the reservoir is a 12-inch cast-iron pipe, and after passing through the filters the water is delivered into two clean water-tanks, situated immediately behind the town at an elevation of 205 O.D.

The combined capacity of these tanks is 600,000 gallons.

The trunk supply main is made up as follows: 12-inch pipe 1550 yards; 9-inch pipe 2400 yards; and 6-inch pipe 750 yards.

The distributing mains are as follows: 6-inch pipe 1650 yards; 4-inch pipe 800 yards; and 3-inch pipe 17,500 yards.

Under certain conditions a distributing system made up of the sizes and lengths of pipe just stated might be tolerably satisfactory, but when, as in Dunoon, the main and only supply pipe is on the lowest level, and a considerable proportion of consumers on the high levels are supplied almost exclusively from a network of 3-inch pipes, the defects of such a system become apparent.

These particulars are noted with a view to invite discussion on the subject of distribution.

The most interesting part of Dunoon's water supply works is the filter plant, which consists of twelve of Bell's 8-feet diameter patent vertical type pressure filters.

Prior to the introduction of these filters the water was passed through four sand beds, having a combined area of 1300 square yards. The filtering medium was 3 feet 6 inches thick made up as follows; top layer 18 inches of coarse sand; middle layer 12 inches of coarse gravel; bottom layer 12 inches of $2\frac{1}{2}$-inch metal.

It was found that these filters did not remove the peaty

discoloration sufficiently, and the Town Council, realising the importance of householders being able to procure clear water at all times, considered it advisable to investigate the merits of mechanical filters.

Exhaustive inquiries were made with respect to the various makes of mechanical filters, the result of which led to the adoption of Bell's filters.

Two filters were put down experimentally, a guarantee being given by the makers that the filtrate would be equal in colour to distilled water, also that the filters would pass 10,000 gallons per hour each.

Both guarantees were fulfilled. The colour of the unfiltered water taken as 100, was reduced in the filtrate 96·7 per cent.

The sand filters reduced the colour 22 per cent.

The period of maximum colour coincides with the period of maximum demand, a coincidence which makes it imperative on account of the limited capacity of the clean water tanks to have the filter power equal to the greatest demand.

Each filter is rated at a minimum output of 6500 gallons per hour, the combined twelve are capable therefore of delivering 78,000 gallons per hour.

During the Glasgow Fair week, when the population to be supplied is estimated at not less than 30,000, the consumpt for the twelve hours 8 a.m. to 8 p.m. is approximately 800,000 gallons, the meter registering at 8 a.m. 50,000 gallons; at 12 noon 75,000 gallons; at 4 p.m. 58,000 gallons; and at 8 p.m. 53,000 gallons. The consumpt per head for the Glasgow Fair week is 27 gallons for the twelve hours 8 a.m. to 8 p.m., and 43 gallons for the twenty-four hours.

One of the advantages which Bell's filter has over the gravity bed is the facility for combining chemical treatment with filtration, and it is this combined treatment applied to Dunoon water which produced decolorisation to the extent already quoted.

But before dealing with the chemical treatment, a description of the filters and their working will be given.

As already stated, the filters are twelve in number. They are situated at the lowest part of the 12-inch main between the reservoir and the clean water tanks.

Figure 1, Plate 1, shows the position of the filters relative

to the main, also the external arrangement of the piping, and is sufficiently explanatory to make it only necessary to describe the internal arrangement and the means adopted for washing.

Each filter contains approximately seven tons of fine Leighton Buzzard crushed quartz, on the top of which the raw water descends. There are 144 strainers at the bottom, conical in shape, with detachable perforated lids having countersunk holes. The narrow ends of the strainers are fixed to 1-inch pipes which in turn are connected to a series of 3-inch pipes, the 3-inch pipes again connecting to the filter outlet. The strainers are filled with pea gravel, and the space between the bottom of the shell and the bottom of the strainer lids is filled with concrete. This arrangement at the bottom induces the whole of the filtering medium to be continuously brought into action, the inclination of the water to descend vertically being no greater at one point than another.

The period of time during which the filters run without washing depends on the condition of the water, and intimation that it is necessary to wash is conveyed by the gauge. When the water is at its best washing is necessary only once in three days; when it is at its worst it becomes necessary to wash twice in the twenty-four hours.

In washing, the 5-inch inlet valve on the top of the filter to be cleansed (see Figure 1, Plate 1) is closed, and the 6-inch washout valve is opened.

The effect of opening the washout valve is to divert filtered water from the 10-inch outlet, which, following the line of least resistance, forces its way up through the sand and out at the bell mouth, the sand by the reverse flow being thrown into suspension. This being done, a vertical, hollow shaft, which rests on the bottom of the filter, and, going up through the filter shell, terminates in a bevel wheel, is made to revolve by means of a pelton wheel driving shafting which engages with the bevel wheel of the filter to be washed, by means of a movable clutch.

The function of the hollow shaft is to supply water to the arms after-mentioned, the supply being obtained from a vertical 3-inch pipe branching off the 5-inch outlet pipe. The reverse flow, occasioned by the opening of the washout valve, causes filtered water to fill the 3-inch pipe. The filtered water is

admitted to the hollow shaft by opening a valve on the 3-inch pipe (Fig. 1, Plate 1).

From this vertical shaft hollow arms, with rakes attached, project, and the rotation of the shaft and arms, together with the action of jets of water issuing from small back-pressure valves on the rakes, completely break up the bed and allow of its being thoroughly cleansed. The upward flow of the water carries the dirt with it, the wash-water being led to discharge into a small stream.

The operation of washing one filter can be done in about four minutes, and it is usual to wash two filters at a time, so that the twelve filters may be washed in thirty minutes.

The chemical treatment consists in adding to the water, before it reaches the filters, certain chemicals which possess the property of extracting the peaty matter contained in the water, and to which discoloration is due.

Two chemical solutions are required, a solution of lime and a solution of alum.

The lime solution is a saturated solution, and the alum solution varies in strength according to the colour of the water to be treated.

These solutions are prepared in three open tanks, two being required for the alum solution; the solution in one of the alum tanks maturing the day on which the solution in the other is being used up.

The solutions are injected into the water by pumps, the power to work which is derived from the water itself, by means of a motor inserted on the 12-inch inlet branch. Plate 1 shows the position of the motor.

The motor is contained in a cast-steel case, 2 feet 4 inches in height and 3 feet 4 inches long over flanges.

The motor occupies a central position inside the case lengthwise, but is eccentric vertically.

The circumference is made up of six hinged blades, and the form of the casing is such that the entrance of the water to the case opens the blades, and the pressure, forcing them on, keeps them in contact with the inside of the casing till they reach the exit opening, when the water is released, and the blades, on reaching the bottom of the case, are closed. The blades at the running ends are fitted with rollers revolving on ball bearings. Lignum vitæ is used for side bearings.

The pumps are connected directly to the shaft, which, so soon as the water is admitted to the motor case, commences to revolve, and immediately puts the pumps in motion.

The alum pump is a vertical, single-stroke pump; length of stroke 3 inches; diameter of ram 1 inch.

The lime pump is a horizontal double-stroke pump; length of stroke, 2½ inches; diameter of ram, 1 inch.

The alum tanks are 5 feet square, and 4 feet deep; the lime tank is 4 feet square and 5 feet deep.

Fig. 3, Plate 1, shows the arrangement of motor, tanks, pumps, and piping from the tanks through the pumps to the inlet.

The alum tanks are filled periodically from the top, and discharge at the bottom.

The lime tank is automatically supplied. The water enters at the bottom, and rises up through a 6-inch bed of gravel, on the top of which is slaked lime.

As lime water it is decanted about 6 inches below the overflow.

The sulphate of alumina is added to the water through the medium of aluminoferric cake, the analysis of which is as follows:—

Al_2O_3	14·00	per cent. minimum.
Fe_2O_3	0·75	"
Free SO_3	0·60	"
Combined SO_3...	34·30	"
Insoluble	0·11	"
Water	50·24	"

At first it was the practice here to add aluminoferric only when the colour of the water demanded it, but for the past year it has been added at each washing.

The hydrate of alumina formed by the sulphate of alumina and calcium hydrate settles among the grains of the top inch or so of sand, the colouring matter of the water forming with the hydrate of alumina an insoluble compound. There is thus little, if any, fouling of the bed below the hydrate of alumina, consequently the arrested impurities are easier removed, and less water is used in washing.

The quantity of aluminoferric used varies according to the season of the year. From July to the end of November the quantity used is much greater than in other months.

The following table shows the varying amounts used :—

TABLE SHOWING QUANTITY OF ALUMINOFERRIC CAKE USED DURING YEAR 1906.

Week ending.	Quantity of water consumed.	Quantity of "cake" used.	Percentage of "cake" to water.
	gallons.	lbs.	grains per gallon.
June 2nd	6,700,000	888	0·927
" 9th	6,822,000	75	0·077
" 16th	6,516,000	125	0·134
" 23rd	6,738,000	687	0·713
" 30th	6,804,000	820	0·843
July 7th	7,176,000	803	0·783
" 14th	7,350,000	713	0·679
" 21st	7,538,000	1038	0·963
" 28th	7,370,000	1071	1·017
Aug. 4th	7,116,000	1465	1·441
" 11th	7,032,000	1800	1·791
" 18th	7,198,000	1700	1·653
" 25th	6,791,000	1725	1·778
Sept. 1st	6,488,000	1700	1·834
" 8th	6,243,000	1448	1·623
" 15th	5,883,000	1330	1·582
" 22nd	5,482,000	1100	1·404
" 29th	5,910,000	1075	1·271
Oct. 6th	5,424,000	1300	1·677
" 13th	5,280,000	1275	1·681
" 20th	5,152,000	870	1·182
" 27th	5,262,000	900	1·197
Nov. 3rd	5,193,000	700	0·943
" 10th	5,090,000	425	0·584
" 17th	5,112,000	675	0·924
" 24th	5,109,000	450	0·616
Dec. 1st	5,103,000	600	0·823

These quantities were added as the quality of the raw water required. In 1906 there was no motor, pumps, or open chemical tanks, and consequently there could not be the same exactitude in adding known quantities of chemicals, as is possible with the new arrangement.

If the motor's revolutions were in direct proportion to the quantity of water passed, one observation would be sufficient to establish a relationship between the revolutions and quantity of water passing. But at 34 revolutions per minute the motor passes 36,000 gallons per hour, while at 68 revolutions per minute it passes 57,000 gallons per hour. So that for double the speed of 34 little more than $1\frac{1}{2}$ times the output at 34 is obtained.

What is required is a meter from which the output of the

filters can be learned at a glance. Having got the output it is a simple calculation to determine the quantities of water and of "cake" necessary to compound a solution of any required strength. For instance, say it is required to add 1 grain of cake per gallon of filtered water when the motor is making 68 revolutions per minute, that is, passing 684,000 gallons in twelve hours, the amount of cake required would be 98 lbs., and the depth of water 32 inches. This quantity of solution should last twelve hours.

The aluminoferric used here is obtained from Messrs. Peter Spence and Son, of Manchester, and costs 3*l.* per ton delivered Dunoon Pier.

The chemical treatment costs on an average 2*s.* 4*d.* per 1,000,000 gallons of filtered water.

The cost of treatment for labour and chemicals is 7*s.* 4*d.* per 1,000,000 gallons.

The total cost including interest and repayment of capital is about 20*s.* per 1,000,000 gallons.

In concluding with a brief reference to the experience gained during six years' acquaintance with mechanical filters, it is necessary to explain first of all that until this year the plant only consisted of six filters.

This year it became evident when washing that two of the filters required cleaning, as the wash arms could not be moved. The inference was that the perforations on the strainer lids had become clogged, and that the amount of water passing up through by the reverse flow was insufficient to throw the sand into suspension.

Accordingly, one filter was shut off and emptied, when it was found that the strainer lids were as suspected.

The sand, however, was absolutely clean, and the examination of the material responsible for the closing of the perforations showed that it was very fine sand.

The perforations in the old filters are not countersunk, consequently it is possible for grit to enter on the top and get stuck in the middle of the perforation, and this is what took place. The strainer lids on the last six filters have the perforations such that any grit entering the perforations will pass through and be caught in the pea gravel, or pass on to the clean water tanks.

The sand, after being six years at work, was deeply stained,

and looked like brown sugar. It was, however, as already stated, absolutely clean. The Author tested the old filters after cleaning the two defective ones, and found the output of the six above their minimum rating, although less than when they were first put down.

The inside of the filter shell showed no signs of incrustation or scaling where it was in contact with the sand. There were slight signs of incrustation on the upper part of the shell free of contact with the sand.

The condition of the filter shell inside was, in the Author's opinion, extremely satisfactory.

As to repairs, all that has been spent on this item was 10*s.* 5*d.* for strained lids, one or two having been broken in removal.

IMPROVEMENTS.

The most important improvement carried out within recent years was the widening of the Shore Road from Moir Street, Dunoon, to Kirn Pier, and the construction of a new front road from Dunoon Pier to Moir Street, thereby making a continuous esplanade between the two piers about 2200 yards in length.

This was a scheme of some magnitude for Dunoon, and one that had often been considered by former Town Councils and as often delayed.

The stumbling-block on each occasion was the finding of the filling-in material, over 100,000 cubic yards being required. When the Town Council instructed the Author to prepare plans for the scheme that has been carried out, they were considering the propriety of forming a recreation ground, embracing a full-sized football pitch with a quarter-mile track round it. The site chosen was a field about 16 acres in extent, the property of the Town Council.

Negotiations had taken place with the Clyde Trustees with a view to get the filling-in material from their excavations at the Clydebank Dock, but this plan was found to be almost impracticable.

It occurred to the Author, however, that there might be sufficient material in the field chosen for the recreation ground, and on going into the question this was found to be the case.

So far as construction was concerned this second contract was a repeat of the first, and requires no special mention.

It however interfered with the conditions that existed for discharging coal boats, and the Town Council accordingly obtained powers from the Board of Trade to construct a harbour for the accommodation of this traffic.

So far only the north arm of the harbour has been built, Messrs. McAlpine being the contractors. It is 225 feet long and 41 feet wide on top.

At spring tides it is left high and dry, and consequently there were no difficulties in construction.

About 40 feet out and 18 inches below the surface a soft tenacious livery clay was found, which, on being exposed to the air and the necessary movement of the workmen, became a mass of unmanageable material that resisted all efforts to excavate it with the pick and shovel.

A Priestman grab worked from a ten-ton crane had no effect on it, and the time between the ebb and flow of the tide (about two hours) was so short that no progress could be made by hand labour.

Accordingly it was decided to found on the top of the clay, and to put in 6-feet lengths of invert 18 inches thick at 10 feet intervals.

There being no likelihood of dredging here, this method was permissible.

The contract price for excavations for foundations was 5*s.* per cubic yard, for concrete in foundations 35*s.* per cubic yard, for concrete in wall 25*s.* per cubic yard, and for filling 2*s.* per cubic yard.

The wall was faced with concrete blocks 2 feet 6 inches by 2 feet 3 inches by 2 feet, cast in wooden moulds, and the backing of the wall was 7 to 1 concrete with displacers. The blocks were made with 5 to 1 concrete with displacers faced with 3 to 1 pure concrete.

Besides the improvements just described there were other improvements of less magnitude, but of not much less importance, carried out.

Two lavatories for both sexes were built, one costing 871*l.*, the other 611*l.*

Figure 5, Plate 3, shows the accommodation provided by the former.

The latter consists of six urinal stalls, three washhand basins, and three closets for gentlemen; and three closets and three washhand basins for ladies, with attendants' rooms.

Both lavatories were built on reclaimed ground, the area of which is 6¾ acres.

Two bathing stations were built at a cost of 198*l.* for the two. Plate 2, Figs. 4 to 9, shows the ladies' bathing station.

A boating station was built at a cost of 800*l.*, and a boat slip at a cost of 539*l.*

Figs. 1, 2, and 3, Plate 3, show the boat slip.

Stairways giving access to the beach were built at intervals of 100 yards, and the stairways are shown on Plate 2, Figs. 1, 2, and 3.

The draining, filling, turfing, and forming track of the recreation ground cost 1451*l.*

The turf on the field was stripped before the navvy came forward, and used in turfing the football pitch.

The turf cost 8*d.* per sq. yard relaid.

The total cost of the work carried out by the Author was 38,000*l.*

The Dust Problem.

Several of the palliatives have been tried here, but owing to rain falling, it was not possible to form an opinion as to their efficiency as a dust layer.

This year the Council decided to experiment on the main street with the Gladwell system of repairing, and the Author was instructed to put down an experimental section of 600 sq. yards.

This was done, and its behaviour will be noted during the summer. The old surface of the road was in no way disturbed beyond brushing it and cleaning it thoroughly before putting down the sub-binder.

The sub-binder was put down about ¾ inch thick, and a coat of 2¼-inch metal 2-stones depth put on top of it, and rolled until the binder showed coming up between the stones.

Then a sprinkling of the binder was thrown on top and rolled into the interstices, to meet the sub-binder.

This method of repairing streets has a great deal to recommend its adoption in those places where for the want of funds a better system is prohibitive. But in the Author's

opinion it is absolutely necessary to its success that the specification by Messrs. Gladwell and Manning be closely followed. It does not appear possible to regulate the sub-binder and metal to varying depths, such as a "cuppy" surface supplies. For this reason old surfaces should be scarified and rolled true as recommended in the specification.

As already stated, in the experimental section carried out here, the irregularities of contour were not corrected, and there are evidences that this was a mistake.

The cost of repairing this section on the Gladwell system was 10*d.* per sq. yard, while the cost of repairing on the old water-bind system was 6*d.* per sq. yard.

Refuse Disposal.

The refuse is cremated in a Horsfall destructor, which has been in operation now for eighteen months.

The destructor is a two-cell plant with boiler power to utilise all the heat generated by the combustion of the refuse. It is in duplicate.

At present there is no steam used except for forced draught, but when the plant was put down it was expected to introduce electric lighting within the burgh. Nothing has been done, however, beyond getting an order towards the putting down of an electric light station.

The cost of the plant, including buildings, economiser, and boilers, was 5066*l.*

The following is a copy of the Test report of last July:—

Date of test	**July 10th, 11th, and 12th, 1907.**
Duration of test	**58¼ hours.**
Number and type of cells	**Two cells "back feed" type.**
Total grate surface	**60 super feet.**
System of forced draught	**Horsfall patent "hotblast" steam-jet.**
Nature of refuse	**Domestic and trade refuse, and slaughter-house offal.**
Number, size, and type of boiler ...	**One "Babcock & Wilcox" boiler, marine C.T. class.**
Economiser, number of tubes	**Green & Sons, 48 tubes.**
Total quantity of refuse burned ...	**56 tons = 125,440 lbs.**
Total quantity of refuse burned per cell per 24 hours	**12 tons.**
Total quantity of refuse burned per sq. ft. of grate per hour	**35·4 lbs.**
Total water evaporated	**137,700 lbs.**

Total water evaporated per hour ...	2354 lbs.
Total water evaporated per lb. of refuse from, and at 212° F. or 100° Cent. ...	1·33 lbs.
Percentage of clinker and ash to refuse burned	23 per cent.
Mean steam pressure	170 lbs.
Mean feed temperature	54° F.
Mean main flue temperature	Over 2000° F. (melted copper).
Mean temperature behind boilers ...	No means of ascertaining this.
Horse-power developed at 20 lbs. steam per I.H.P. per hour	117·68 H.P.

DISCUSSION.

MR. JAMES MURRAY: I have no doubt that in many ways the filters described are a great improvement over the old sand filters, especially as they can be placed in a very small space, but my opinion is that it is impracticable to adopt them in places where there is only a limited supply of water. From 2½ to 5 per cent. of water is stated to be used for the cleaning of the filters, but I think it is nearer 10 to 15 per cent. as a rule. The man in charge of the filters has no particular object in saving the water. Another thing is that it is necessary to clean the filters frequently to produce good water, especially in the months of June, July, and August, these being the months in which the highest consumption is recorded for the year. If the operation is performed once a day, some twenty minutes or half an hour is occupied cleaning the filters. Every one present knows that a pipe, say 3 inches in diameter, running under pressure for half an hour, takes away a considerable quantity of water. Filtered water is used to clean the dirty filters, and the operation results in a certain amount of filth being carried into the first filters, and *vice versâ*. Taking all that into consideration, I think that if some better method for cleaning the filters could be adopted, the system described would be more universally used. I have been told that, as a result of the use of alum, a 3-inch pipe has been contracted in seven months to almost a 2-inch. I do not know of any filter which gives us such good results in the colour of the water. Good sand unfortunately is becoming very scarce for filtering purposes; in fact, the material has been brought from Ireland at a cost of 18*s.* 6*d.* per cubic yard. These filters have the advantage that the filtering material is limited in quantity and not so expensive to replace,

and there is no chance of suspended material being carried into the domestic supply. At Dunoon the population varies from 9000 to between 35,000 and 40,000, and although there may be plenty of water for 10 months of the year yet they have to provide for say 40,000 during the other two months of the year Dunoon is, to a certain extent, favourably situated. The water area supply is moorland, of large extent, and has a good fall to the reservoir. I have seen the reservoir filled with a supply of water sufficient for 130 to 200 days in the short period of seven hours. I congratulate Mr. Andrews very heartily on the instructive paper which he has prepared, and I have great pleasure in moving a hearty vote of thanks to him.

Mr. G. D. Mackie: There is a great deal of prejudice against mechanical filtration, and I think this is to a great extent justified, because, unless the apparatus is worked on scientific principles, the chances are that some of the coagulant will get through the filter into the filtrate and in that way set free the nodules in the pipes. If you supply an acid water—no matter how slightly tainted it is with acid—that water is unfit for domestic consumption. Therefore, the question of mechanical filtration must be gone about very cautiously. I notice that there is only 37 feet difference between the top water level and the pure water tanks. He might let us know what is the depth of the outlet of the storage reservoir. I must join issue with Mr. Andrew when speaking of the drainage area; he says, "It is unfortunately lined with sheep drains and these allow the water to flow off rapidly, producing a twofold effect the reverse of beneficial." In my opinion it is highly beneficial, because when you have a gathering ground undrained the water lies on it instead of rapidly passing down through the drains to the reservoir. I have visited many of the important installations of mechanical filters in Scotland and in England, and what struck me in this installation is that the Town Council have got two guarantees, one for clearness and one for rapidity of passage of the water through the filter bed. I think one guarantee that ought always to be obtained is this—that none of the sulphate of alumina will be found in the filtered water, because unless you have that the water is bound to act on the pipes. I have sand filters that have not been cleaned for six weeks in summer, and I think if you have a normal plant you can pass the water through it at

nearly as high a rate as you can with these filters, but in that case you will not get the same benefit. Of course, in this case, you have a pressure, and only the head of water with a sand filter. There is an enormous difference in the rate of filtration between a slow sand filter bed and that given in the paper for these filters. A slow sand filter generally filters at about 500 gallons per square yard per day. I have worked out the rate in this installation, as given in the paper, and find it is 43,000 gallons per square yard per day. Even in America the general practice is not to allow the rate of filtration to exceed 30,000 gallons per square yard per day. The work of the filter depends upon the quantity and the kind of the coagulant, and the way it is introduced into the filter. Touching this same point of the rapidity of the filtration, the scum which is formed by this coagulant is an artificial scum, and one can see the danger, if the pace is forced too much, that the scum will be broken and impure water forced into the filtrate. Mr. Andrew says, "One of the advantages which this filter has over the gravity bed is the facility for combining chemical treatment with filtration, and it is this combined treatment applied to Dunoon water which produced decolorisation." If Mr. Andrew means the slow sand bed I agree, but if he means the other kind of mechanical filter, which is known as the gravity filter, I fail to see how the filter described is superior.

MR. ANDREW: I mean the open sand bed.

MR. MACKIE: If you look at the number of installations in America, in Africa, and at home, you will see that the pressure type of filter is being replaced by the open gravity filter. In order to have successful filtration with a coagulant you must have absolute control of the coagulant, and you must have sufficient storage of the water between the introduction of the coagulant into the water and its delivery to consumers, in order to allow the chemical reaction to take place and not send the hydrate into the consumers' pipes. You must also have an absolutely regular rate of filtration. In the case of Dunoon I do not think any of these three points are carried out. Mr. Andrew tells us he has great difficulty in controlling the rate of the introduction of the coagulant into this filter. When I visited the filters in 1907 I could not see that there was any attempt made to control the introduction of the coagulant. It was put in at the will of the attendant, and the method of

working was very erratic. If you had a gravity bed the chemicals would be introduced by gravity and at a uniform rate as compared with the water, and I think in that way you would get a uniform result. I think if the filter had been at a higher level, and the coagulant had then been introduced by gravity, and the water allowed to settle before going into the filter bed, a good deal better results would have been obtained. I should like Mr. Andrew to tell us in what way he determines the amount of sulphate of alumina he has to use for a given quantity of water. I know that Mr. Andrew says, " At first it was the practice here to add alumina ferric only when the colour of the water demanded it, but for the past year it had been added at each washing." If the amount of the coagulant is determined merely by the colour of the water then the results must be crude and inaccurate. There is only one way in which the amount of coagulant to water can be determined, that is by determining the alkalinity of the water. In the first place peaty water is very soft. If you get an excess of alumina in the water you are bound in the long run to get free acid into your water, and if you have the least trace of free acid then that water is unfit for domestic purposes. Then again, Mr. Andrew speaks of this coagulant as fed direct into the filter bed. That is wrong, because you must allow some time for the thorough mixing of the coagulant with the water. In this case it is almost instantaneous, and the reaction of the chemical treatment may not take place until a portion of the water is delivered to the consumer. If you have a bed for sedimentation to take place you can satisfy yourselves that chemical reaction has taken place before delivery of the water to the town. In that way you will save a good deal of unnecessary work on your filter, because you will not require to clean it so often. Then you must have an absolute uniform rate of filtration. If you have not there is a chance of your breaking the scum on the surface of the sand. I do not think there can be any comparison between the results of a slow sand filter and the mechanical filter. You know you can get a perfectly pure water with a sand filter; of course, I do not mean a colourless water, because I do not look upon discoloration as an impurity. If you want a colourless water you must, of course, have chemical treatment. Now, taking up Mr. Murray's point as to the washing water, I find it is generally put at 5 per cent. of

the water filtered. If you are filtering a million gallons it means that 50,000 gallons are required for washing water. Mr. Andrew has put the cost of the treatment in these filters at 20*s.* per million gallons. I should like to ask if he has included anything there for washing water.

Mr. J. S. Brodie: Discoloured water may not be dangerous to health, but sentiment enters largely into these matters, and I think the public are justified in complaining if water is not reasonably clear. I have had no experience of mechanical filters, for the water at Blackpool gives no trouble; so I think our thanks are due to those enterprising engineers—Mr. Andrew among them—who have tackled the question and done their best to solve the problem with satisfaction. I think it is a step in the right direction of supplying the public with a water that is both clear and wholesome. But the sea-defence works are even more interesting to me than the work of mechanical filtration. I have yet to inspect them, but, speaking from what I have read in the paper, I have to heartily congratulate Mr. Andrew on the success he has attained in a very difficult subject indeed. Naturally those who have to fight Father Neptune in his attacks on the shores of this country appreciate the difficulties to be faced. The filling of the wall has been very considerable—namely, 100,000 cubic yards—and I find that the cost of carriage, excavating, etc., is very heavy. I take it there was no sand available on the seashore, for we all know that sand is really the cheapest material to use for filling when it is available. At Blackpool we put about one million tons of sand from the foreshore behind our new sea-wall, at a cost of less than 6*d.* per ton; but of course it would be more expensive at Dunoon, owing to the difficulty of obtaining the material. I notice that Mr. Andrew speaks of the legal difficulty which he has encountered with the owners of the foreshore. It is more the custom in England for the authorities to purchase the foreshore, and this has been done at Blackpool at a merely nominal figure. In regard to the displacers, I think Mr. Andrew has been very successful in his contract price of 18*s.* per cubic yard for foundation, and 14*s.* 6*d.* for the wall, including facing. That is very reasonable. In making up a solid filling behind a sea-wall, there is likely to be a certain amount of subsidence with clay, which will result in a hollow space being formed. Sand does not give that trouble. I should

like to know what is the cost of the wall itself per lineal yard —I mean the wall as distinct from the backing. Mr. Andrew has stated that the contract price for excavations was 5*s.* per cubic yard; for concrete in foundation, 35*s.* per cubic yard; for concrete in wall, 25*s.* per cubic yard; and for filling, 2*s.* per cubic yard. I consider all those prices are very reasonable, though at Blackpool we prefer to do our own work without resorting to contractors. By doing the work yourselves, you might have saved a little money.

With regard to the dust problem, I have used no end of palliatives, and my experience has been that they will only act for a short time. Some more permanent system of making dustless roads is obviously necessary.

I shall be glad to know whether the destructor at Dunoon is of the top feed or an open-front type. In my Blackpool destructor, I insisted upon a top feed, because in places like Blackpool and Dunoon you have to conduct your refuse destruction with the least possible nuisance to visitors, and the great problem is to not have any offensive smells coming from the destructor at all. We had to go a little out of our way to do that, but we accomplished it in the end. I shall be glad if Mr. Andrew can tell us the cost per ton of refuse for collecting, and for cremation after the collection is made—I mean the wages only, and not interest and payments of sinking fund, for every town has its own system in regard to the latter. I shall be glad to know also what use is made of the residuals and the waste heat. At Blackpool we utilise most of our waste heat in providing power for breaking stone, sawing wood, and in other ways. We separate all fish refuse instead of burning it in the destructor, and make a fish manure, at a cost of 1*l.* per ton, for which we get 4*l.* per ton. Fish refuse has a most deleterious effect if burned in the destructor. Then we have no end of oyster shells in Blackpool, which are ground up in mortar mills, and the powder sold for the feeding of chickens. There is a good sale for it; in fact, we could sell more than we make.

Mr. Holmes: In the original filters there seems only to have been 3 feet 6 inches or 3 feet 8 inches of filtering materials. I presume it would not have materially improved matters if the depth of filtering materials had been increased to 5 feet or 5 feet 6 inches, as the difficulty seems to have been to deal, not with

an impure water, but with a discoloured water. Personally, I would prefer to drink a water which was only discoloured, rather than a water which was treated with unknown chemicals. One thing which has specially interested me in reading Mr. Andrew's paper is the large amount of money which the Dunoon Council has spent during the last fifteen years or so. It would be interesting if Mr. Andrew would give us some idea of the rates of assessment in Dunoon, as I should think that with an assessable rental of 77,000*l.* and a recent capital expenditure of about 150,000*l.* they must be fairly heavy, unless the profit from the pier helps to reduce them. With reference to the Esplanade, I quite agree with the remarks of Mr. Brodie. The price of the wall struck me as being exceedingly moderate. Even the filling for the promenade from the football field does not seem to be out of the way at 1*s.* 4*d.* per cubic yard; when you take into consideration the distance it had to be carted, I think the Dunoon Council are to be congratulated upon the economical results obtained in the construction of their Esplanade. In reference to the trial of the Gladwell system of road-making, I think Mr. Andrew is right in saying that it is a mistake not to scarify the road in the first place, because I can see that there are likely to be difficulties if you do not start with a uniformly even surface. Probably that mistake will not be repeated in any local extension of the system. The cost at Dunoon of 4*d.* per square yard is not a serious addition to the cost of repairing by the older method. I think Mr. Gladwell claims that it can be done for 2*d.* or 3*d.* extra per square yard, but I am afraid his estimate is rather under the mark. With reference to the refuse disposal, the first thing that struck me was the cost of the installation, which is quoted at 5066*l.* for a 2-cell destructor. In Govan we have eight cells, and the cost was only about 800*l.* more.

Mr. Andrew: It is a 2-cell plant in duplicate.

Mr. Holmes: That explains the difference. It would be interesting to know the cost of burning the refuse at Dunoon. Something like 1*s.* per ton seems to be the average by other destructors. I should also like to know to what extent you work your plant. Our last installation at Govan, with forced draught, is guaranteed to burn 10 tons per cell per day, but we only work it up to 6 or 7 tons per cell per day; to work it up to the full capacity might involve very heavy outlays for

maintenance. We made a very favourable arrangement with the firm who built our latest destructor. They undertook to maintain it in good working order for a period of five years at a fixed rate per ton burned, and at the termination of that time they undertook to maintain it for a further period of five years, and we expect to have an installation as good at the end of ten years as at the beginning of that period, and if that is so our expectation of a life of twenty years for the destructor is likely to be realised.

MR. C. BROWN: I have laid 3000 yards of road on the Gladwell system. I must say, I have had a good deal of trouble with the surface, the horses' feet apparently kicking up the small stone. I have painted a thousand yards of the newly finished road with the hot tarvia, and that I find properly seals the surface and makes a good road. I found the price a good deal dearer than Mr. Andrew. I had to excavate the road 5 inches to begin with. I paid 6½*d.* per gallon for the tarvia. I understand that you can get this material in England a good cheaper than that, the carriage being less.

MR. J. YOUNG: It is something new to me to learn that so much chemicals are required in the operation of the filters described. I have to deal with a peaty water, which is brought a distance of 19 miles to our filters. The way we get rid of the peaty matter is by turning the water into a large service reservoir, where it lies for a considerable time, and undergoes sedimentation, aëration, and exposure to sunlight. Afterwards it passes into six large sand-filters, and in the end we manage to produce a good water. If they are properly looked after, it is quite possible, with ordinary sand-filters to deal with a peaty water, to get a very presentable water indeed. Of course, you cannot always have these conditions in a place like Dunoon, where the gathering ground is close to the town, and limited in area. In such a case you must filter rapidly, and, as a consequence, the peaty stain is very much exaggerated in the water. As regards the sheep drains, I do not consider it any disadvantage to have these on the gathering grounds, for they help the water to pass off rapidly—a great advantage. As regards sea-walls, I should like to ask Mr. Andrew and also Mr. Brodie —whom we are pleased to see with us in Scotland—whether the erection of the sea-wall has promoted additional erosion on the sea-beach. That is a question which may have been under

the observation of surveyors of seaside towns. I have had an unhappy experience of a fore shore about three-quarters of a mile in length. Seven years ago the foundation of the esplanade wall had a covering of from 2 feet to 3 feet of sand, but at the present time it is 3 feet below the foundation of the wall, and the only thing to do has been to protect the toe of the foundation by putting in groynes the whole length of the esplanade. Possibly Mr. Andrew has had a different kind of foreshore to deal with in Dunoon. I rather think, after looking at it, that a great deal of rock must have been encountered, but there may have been bad ground to contend with, and I shall be very pleased to hear in the reply what was done when soft material was met, whether the foundations were strengthened or any precautions taken for strengthening or deepening the toe of the wall. I notice that Mr. Andrew faced up his wall with a different material from that in the heart of the wall, and I should like to know how that was got into place in the work. You have in Dunoon a destructor of the back-feed type. Am I to understand that there are two units of two cells in that destructor?

MR. ANDREW: Yes, absolutely in duplicate.

MR. YOUNG: Four grates.

MR. ANDREW: Yes.

MR. YOUNG: Top-feed destructors have been the subject of much controversy among surveyors, and I must say that one I know of was very disappointing. After the refuse was tipped down, the ironwork of the charging opening became red hot, and set the refuse on the furnace cooking and stewing. The result was that it was decided to alter the destructor to one of the Horsfall type, and in order to put an end to the cooking and stewing I have referred to, they laid down a 6-inch hollow floor of agricultural tiles laid in concrete, and passed through it a current of cold air. I have at present in my burgh a Meldrum front-feed destructor, and with that there is no nuisance of the kind I have spoken of. I am experimenting and doing my best to find some material combined with macadam which will not require very much renewal, at the same time keeping a permanent surface and preventing dust. As long as we have whinstone macadam to deal with and water-binding, it is certain that we shall have dust. I shall, therefore, be very interested to see the result of the use of the

tarvia binder. My view is, that it is not the right thing to lay tarred metal, or even tarvia, on a road that has not been previously scarified. The proper course is to scarify the road thoroughly and bring the road to a proper curvature and even surface, put on the stone, and then roll it. You will find the same difficulty when you make a new road with hand-pitched bottoming. If you have many depressions in the foundation, they are sure to repeat themselves in the top surface. It is not practicable to manipulate tarred metal in the same way as water-bound material. In connection with this dust question I intend to try an experiment on some 4800 yards of a new road laid in the following manner. I take $2\frac{1}{4}$-inch machine-broken whinstone metal, screened, and I lay that $3\frac{1}{2}$ inches or $4\frac{1}{2}$ inches thick. I then take $1\frac{1}{2}$-inch metal and give it a slight sprinkling over the road so as to very nearly fill up the interstices. Then I bring on a tar spraying-machine and thoroughly tar-spray the road several times, and roll it hard. Having put on the top dressing of tar and chips, I again roll the road to its finished surface. In that way I am hopeful of making a road nearly equal to tar macadam. The cost of the tar-spraying for the machine and the composition of tar and other ingredients is quoted to me at something about *4d.* per yard, but from that *4d.* I have to deduct the saving in the carting of the water, the sand and gravel, and the brushing and sweeping required to make an ordinary water-bound road.

MR. J. R. WILSON: There is one point in the paper which previous speakers have passed over—that is, the distribution of the water. I see from the paper there is some 17,500 yards of 3-inch pipe. I consider that an enormous quantity of small pipes for a burgh like Dunoon. In my burgh I have great difficulty in supplying from a 3-inch pipe, owing to the heavy draw. To obviate that, in a good many places, we have laid 5-inch pipes in place of 3-inch. With the larger pipe I find less waste and a better supply of water, while it is of more use in case of an outbreak of fire. I think it would be an advantage to Dunoon if Mr. Andrew had permission to take up half of these 17,500 yards of 3-inch pipe, and replace them with 5-inch. You would find the benefit in less waste, and fewer complaints from consumers.

MR. J. P. SPENCER: To my mind the most important part of the discussion to-day has been with regard to the mechanical

filtration of the water. It is a difficulty which I fear has yet to be satisfactorily solved. Primarily, to have soft water you must, in its natural state, have it somewhat discoloured. A white water is always a hard water. I am exceedingly sorry to find with many consumers a certain amount of prejudice obtains against a water which has any amount of discoloration, because from medical testimony—though doctors differ on this as on many other subjects—in chalk districts certain diseases are more prevalent, where the water is of a hard, limey nature. I have some experience of the chalk districts in the southern and western parts of England, and whether it is from the domestic water supply passing through the chalk hills I cannot say, but a tendency to cancer is said to be more prevalent in some of those districts than where a soft and originally discoloured water is supplied. On the other hand, it is said that the hard water full of lime—or rather, I should say, full of the effects of passing through the lime—is better for bone formation in children, but even in that doctors differ, and to have the full force of truth it must be taken that children live on water and nothing else. The bone formation is more largely contained in the food they eat than in the water they drink. Therefore, I think in those parts of Scotland, and some parts of the North-East of England, where the water is soft, although somewhat discoloured with an absolutely harmless element, namely, peaty discoloration, there is no reason to complain, or to be at all downhearted about it. At the same time we cannot disguise the fact that the ordinary consumer has a prejudice against a water which is not supplied to him a pure white. I am afraid that sometimes they like it to be not only white but sparkling. We know that a sparkling water contains carbonic gas, chiefly derived, in the case of well water, from contamination by sewage. But it looks all the prettier to the eye for the contamination. I think the mechanical filtration might be supplemented afterwards by a certain amount of sand gravitation filtration, but to obtain that object it would have to be known before the works were designed, because it very largely resolves itself into a question of levels. That brings me to this question: What does Mr. Andrew find the minimum head of water necessary to work the motors and the filters? The success or otherwise of mechanical filtration must to some extent depend upon the level you have at your

disposal between the storage reservoir and the clear water tank. The question of the retaining wall at the esplanade is most interesting, and I am very glad to see that Mr. Andrew has given Dunoon the benefit of the sectional shape he has done. One of the greatest drawbacks to the sea walls and promenades of many of the chief watering places is that when the wind is direct upon the coast the waves wash up and break upon the promenade. It is evident from the section that such an objection cannot happen at Dunoon. Another good feature is the manner in which the sheeting is secured at the back of the wall to keep it in position. The dust problem is always to be with us, as we are told that the motor car is always to be. It occurs to me that it is very unreasonable on the part of users and owners of motor cars that they appear to think they have only to demand a road which shall create no dust. That, I am afraid, is not likely to be accomplished, though efforts are now being made by surveyors throughout the kingdom to minimise the amount of dust on the roads. Owners of motor cars think the problem would be solved if a road was made which did not create dust. That is a great mistake, as every surveyor of practical experience knows the dust upon a road is not altogether produced by friction and wear upon the road itself. Dust comes from many quarters, and even if you got a smooth and hard surface you would still have the dust which comes from adjacent places and settles upon the road. Therefore the effort ought to be mutual, and the users of motor cars should be a little more strenuous in their endeavour to alter the construction of motor cars so as not to throw so many obstacles in the way of a satisfactory result.

The Chairman: We have, in Paisley, a pressure filter through which we pass a little water to serve a few villas in an outlying district. The water is taken direct from the reservoir, and, though the water is pretty clear, we put the filter in so that we might assure the residents that the water is properly filtered. Like some others, I am a strong supporter of sand filtration. In Paisley we have nineteen very large sand filters, and we are completing another three of the same size. Like Mr. Young, my opinion is that if towns can have sufficient storage—and large enough storage reservoirs—you will get rid of the trouble in filtration. Corporations should look further ahead. They look for sufficient size in reservoirs

and filters to last for about thirty years, but they should get a very much larger area, particularly for filters. The cutting of the sheep drains on the gathering area is a very good idea. Three years ago we spent a considerable sum of money in cutting sheep drains on our gathering area. This has proved a great advantage. We get the water very much quicker, and the ground has dried. Of course, at the beginning we had trouble by water being very much discoloured. I should like to congratulate Mr. Brodie upon getting 7*l.* 10*s.* a ton for some of his refuse.

REPLY TO DISCUSSION.

Mr. Andrew, in reply, said: I am glad the paper has called forth so much discussion. I do not intend to say that we are by any means perfect in the treatment of the water by the system we have in Dunoon, but we are making improvements every day. You are not to think that the water is being treated because of any slight discoloration in it. It has not been possible by sand filtration to remove the deep stain of peaty discoloration. The Council, just prior to my coming here, had decided to put in Bell's filters. The colour of the water at this time of the year is very pronounced, more particularly after rain. Mr. Mackie asked how we estimated the quantity of sulphate of alumina to use. As it is purely a question of removing colour, it is colour that determines the quanitity used. What has been done in this matter is the result of experience. I have given in my paper a table showing the quantities of aluminoferric cake used in different months. It will be seen that the highest ratio of "cake" to water is 1·834 grains per gallon. As 50 per cent. of the "cake" is water, there is only about 0·9 grain of sulphate of alumina, and as it takes about seven grains of sulphate of alumina to make one grain of alum, the quantity of alum is about one-eighth of a grain per gallon of water. Mr. Mackie mentioned the danger of the coagulant getting through if the filters are pressed. That has happened here before the plant was doubled, when I saw hydrate of alumina in the clean water tanks. Mr. Mackie laid great stress on the absolute necessity for a uniform rate of filtration. I can only presume that he meant a maximum rate. Filters cannot be worked at

a uniform rate, at least, not in Dunoon, where the demand is much greater at one time than another. So long as the filters work well at the maximum rate they are bound to work better at a slower rate, and I apprehend no danger now of any coagulant passing through. My calculation of the maximum amount of water used in washing brings it out at from 3 to 3¾ per cent. Sometimes we do not wash more than three times a week, sometimes we wash three times a day, so that the quantity is very variable. Mr. Mackie's statement that Bell's filter without the use of a coagulant would not filter or purify water, is misleading. I have these filters at work in other parts of the county without the use of chemicals, and the results are highly satisfactory.

Mr. Murray made the strange remark as to filtered water being used to clean the dirty filters, "this resulting in a certain amount of filth being carried into the first filters and *vice versâ*." I consider the washing of the filtering material by filtered water one of the best features of the filters, and as for filth being carried into any of the filters during the operation of washing, I have only to say that such a thing is impossible, as neither in filtering nor washing does any of the water that has passed through a filter as filtered water or wash water, pass through any other filter.

With regard to the filling behind the sea wall, and Mr. Brodie's remarks as to the cost, there was no filling to be had on the foreshore. The filling obtained from the excavations in the field was gravelly soil and rock. There was some sandy clay, but the greater part was gravelly soil.

As to the displacers, the wall is a comparatively thin wall, but as large displacers as possible were used. The average price for the wall would be about 5*l.* per lineal yard, the maximum about 12*l.* As to the foreshore rights, the Council have got the most of the foreshore on lease from the office of Woods and Forest and the Board of Trade, at a nominal annual payment. As to the refuse the cost of collection is variable, but the price for cremating is about 1*s.* per ton.

The defect in the distribution of water which becomes apparent owing to the great number of 3-inch mains is reduced pressure occasioned by the high velocity of the water, which also has a scouring effect on the dirty incrustation, removing nodules and causing dirty water.

The "tarvia" liquid cost 6*d.* per gallon delivered on Dunoon pier.

In reply to Mr. Young's question as to the possibility of erosion on the beach, there are no signs of erosion apparent. The beach has changed in appearance somewhat since the wall was built, but this is due to the contractor having removed a great number of boulders lying about the foreshore. From levels I have taken recently, I find that the beach has assumed practically the same level to the new wall as it bore to the old wall, the level at the new wall being in some places 2 feet 6 inches above the surface of the old beach.

Mr. Young also referred to the facing of the wall, and asked how it was put in. There was a movable iron plate with handles, the plate measuring about 5 feet long and 18 inches deep. This plate was kept the required distance from the face by means of 4 inches by 2 inch battens, and was held in position at the back by displacers. When the backing was brought up to the level of the top of the plate, the facing was run in, and the battens and plates pulled up, to be fixed again.

Mr. Spencer referred to the head of water necessary to work the filters. We have plenty of head in Dunoon, more than the makers say is necessary. I understand from the makers that 11 feet of head is sufficient for filtering, but for purposes of washing more head is necessary, about 20 feet. From my experience of the filters I have no reason to doubt these figures.

The Dunoon Town Council entertained the Members to luncheon in the Town Hall. The remainder of the afternoon was occupied with visits of inspection to the Waterworks, the Refuse Destructor, the Esplanade, and the Promenade.

In the evening the Annual Dinner of the Scottish Members was held at the Argyle Hotel. Later the Members, by the invitation of the Council, attended the Concert held in the Pavilion at the Castle Gardens.

On Saturday, June 20, the Members visited the Craigmuschat Quarry at Gourock, where they were received by Mr. A. A. R. Lang and members of his staff, and conducted over the quarry, where an opportunity was given of witnessing the manufacture of tar macadam, rock drilling, and sett-making. The Members were entertained to luncheon by Mr. Lang.

THIRTY-FIFTH ANNUAL MEETING.

NOTTINGHAM, *June 25, 26, and 27*, 1908.

MR. J. PATTEN BARBER, M.INST.C.E. (PAST PRESIDENT),
in the Chair.

THE Members assembled at the Shire Hall, Nottingham, and were received by Lord Belper, Chairman, Notts County Council.

Mr. J. Patten Barber, in the unavoidable absence of the President (Mr. John A. Brodie), returned thanks on behalf of the Association.

The Secretary read the minutes of the Thirty-fourth Annual General Meeting, which were confirmed and signed.

The Secretary then read the 35th Annual Report of Council:—

ANNUAL REPORT.

The Council have much pleasure in presenting their Annual Report.

Since the last Annual Meeting the changes in the constitution then authorised by the Members have come into effect. The new class of Associate Members has already justified its formation, ten gentlemen having been elected and twenty-nine transferred thereto. The financial changes are dealt with later on in this Report under the head of Finance.

DISTRICT MEETINGS.

Since the last Annual Meeting, ten District Meetings have been held:—At Westminster, July 6, 1907; Bilston, September 14; Teignmouth, October 19; Hampton, October 26; Westminster, February 28, 1908; Wimbledon, May 2; Eccles,

May 9; Norwich, May 30; Blackpool, June 13; and Dunoon, June 19 and 20.

The thanks of the Association are greatly due to the Members who have so kindly placed their experience and work at the disposal of their brethren, and to the various District Secretaries for their endeavours in arranging meetings in their respective Districts. The Council note that there is an excessive difficulty in arranging meetings in certain of the Districts, and confidently appeal to the Members in whose District no meeting has recently been held to come forward and help their Local Secretary in the arduous task of arranging, and successfully carrying out, a meeting. The value of these gatherings by interchange of professional views and experience, coupled with the opportunity of inspecting the works visited and described, is of the first importance to the Municipal Engineer who would keep himself abreast of the progress of his profession.

The Roll of the Association.

During the financial year ending April 30 last, 48 new Members, consisting of 13 ordinary Members, 10 Associate Members, 7 Associates and 18 Graduates have joined the Association. Eighteen Members have resigned, 19 names have been written off or not re-elected, and the Council record with regret the deaths of Messrs. R. C. Mawson, H. Nettleton, J. Pollard, L. Stevens, W. Stringfellow, W. Thwaites, and R. F. Vallance.

The numbers on the roll of the Association at the close of the year were 9 Honorary Members, 834 Ordinary Members, 39 Associate Members, 123 Associates, and 204 Graduates, making a total of 1209.

—	1902 to 1903.	1903 to 1904.	1904 to 1905.	1905 to 1906.	1906 to 1907.	1907 to 1908.
Hon. Members	8	10	10	10	9	9
Members	810	813	852	844	850	834
Associate Members ..	—	—	—	—	—	39
Associates	83	93	123	138	144	123
Graduates	133	144	158	180	204	204
Total	1034	1060	1143	1172	1207	1209

The Council have transferred 6 Associates and 2 Graduates to the class of Members; 24 Associates and 5 Graduates to the class of Associate Members; and 9 Graduates to the class of Associates.

The Finances.

The audited Balance-Sheet and Statement of Revenue and Expenditure which accompanies this Report shows a balance carried forward at the close of the year ending April 30 last, of 28*l.* 3*s.* 5*d.*

The increase in entrance fees and subscriptions has, as yet, only been partially felt, in the revenue side of the Association's finance.

Although on the expenditure side a most satisfactory diminution has now been effected in the necessarily large item of printing, due to the acceptance of a tender in very strict competition with selected firms throughout the country, a careful study of the balance-sheet will be found to fully justify the Council in their recent request to the Members to place the income of the Association on a footing commensurable with the importance of the work now devolving upon the Council, if the best interests of the Association and the Municipal Engineering profession generally are to be maintained.

Examinations.

Since the last Report four examinations have been held, at which 74 candidates presented themselves for examination. Of these, 32 satisfied the examiners and have been granted the testamur of the Association.

The Board of Examiners have, during the past year, devoted careful thought to the methods of examination, and upon their recommendation your Council have decided that before a testamur is granted, the candidate must have obtained a satisfactory "pass" in each of the five sections of the examination. Also that a candidate failing in not more than two sections shall in future be allowed to sit for re-examination only in the subject or subjects in which he did not satisfy the examiner.

PREMIUMS.

The Council have awarded the Association premium of 5*l*. 5*s*. to Mr. E. E. W. Butt (Graduate) for his paper on "Storm Water Discharge," read at the last Annual Meeting. Premiums of 3*l*. 3*s*. have also been awarded to Mr. J. W. Leebody (Member) for his paper on "County Road Maintenance," read at Belfast, and Mr. T. Aitken (Member) for his paper, "The Maintenance of Roads," read at St. Andrews.

THE NEW COUNCIL.

The Scrutineers, having examined the ballot lists, report the following members elected as the Council for the year 1908–09:

President.—Mr. E. Purnell Hooley.

Vice-Presidents.—Messrs. W. N. Blair, J. Paton, and C. F. Wike.

Ordinary Members of Council.—Messrs. C. H. Cooper, J. W. Cockrill, A. T. Davis, A. Fidler, A. Gladwell, A. D. Greatorex, W. Harpur, T. W. A. Hayward, P. H. Palmer, J. S. Pickering, R. Read, H. E. Stilgoe, R. J. Thomas, H. T. Wakelam, and A. E. White.

Hon. Secretary.—Mr. Charles Jones.

Hon. Treasurer.—Mr. Lewis Angell.

The Past-Presidents (ex-officio Members of Council) are Messrs. A. E. Collins, J. Patten Barber, and J. A. Brodie. The elective Past-Presidents are Messrs. T. H. Yabbicom, J. Lobley, and O. C. Robson.

The Council consider it desirable that members should in future vote for not less than fifteen ordinary members of Council, and propose to ask the members to alter the Bye-laws governing the method of election of Council accordingly. The Council also feel it desirable that power should be given to them to co-opt one ordinary member of Council representing Scotland, and one ordinary member of Council representing Ireland, in case no such member or members be returned as elected in the ordinary way.

DELEGATES TO OTHER BODIES.

The following gentlemen have served or are serving as delegates on behalf of the Association:—

Mr. Charles Jones (Hon. Secretary) to the Sanitary Inspectors' Joint Examination Board.

„ W. Nisbet Blair to the N.A.L.G.O.

„ A. E. White „ „

„ J. S. Pickering „ National Housing Reform Council (Letchworth Exhibition).

„ H. T. Wakelam „ Roads Improvement Association and National Dustless Roads Committee.

Mr. T. W. A. Hayward to the Plumbers' Registration Committee.

„ A. E. Collins „ R.I.B.A. Joint Committee Reinforced Concrete.

„ J. W. Cockrill „ „ „ „

„ W. Harpur „ Engineering Standards Committee.

„ C. F. Wike „ „ „ „

Messrs. J. A. Brodie, E. P. Hooley, T. W. A. Hayward, H. T. Wakelam, H. E. Stilgoe, R. J. Thomas, C. F. Wike, W. J. Taylor, and the Secretary, to the Paris Roads Congress.

Reports from Delegates.

The Sanitary Inspectors' Joint Examination Board.—Mr. Chas. Jones: The operations of the Board have been extended beyond London with much success. A large number of candidates, including many ladies, have been examined during the past year. The Board are glad to find that a high standard of knowledge has, as a rule, been displayed by the candidates.

The N.A.L.G.O.—Mr. W. Nisbet Blair: The quarterly meetings of the National Council during the past year have been held at Manchester, London, Hull, and Cardiff. Sir Homewood Crawford, solicitor to the Corporation of the City of London, has been elected President for the year, and Mr. H. E. Blain, of West Ham, was re-appointed Chairman of the National Council.

The Superannuation Scheme has been repeatedly considered by the Council, and a Conference has been held with representatives of the Association of Municipal Corporations with the object of securing the support of that body.

The scheme has been submitted to the Local Government

Board, and an interview with the President sought, but only with the result that, having regard to the pressure of public business, he was unable to consider the question at present.

At the Cardiff meeting on May 2, instructions were given for a draft Bill to be prepared with the idea of submitting it to Parliament next Session.

Propaganda work has been vigorously and most successfully pursued; new Guilds or Associations have been and are still being organised throughout the country, the number of Guilds now affiliated being 50, and the local membership 15,000.

The whole area of England and Wales has been divided into eleven districts, in each of which there is to be formed a District Association, constituted of representatives of the local Guilds, and each District Association is to elect members of the National Council proportionate to their membership. This will not affect the relationship of Professional Associations to the National Association.

The Letchworth Garden City Competition.—Mr. J. S. Pickering: The Council were invited to nominate a Judge to assist in awarding prizes for artisans' houses of various types, erected in connection with the Letchworth Housing Exhibition, 1907. Together with representatives of the Royal Institute of British Architects and the Surveyors' Institution, I made an inspection of upwards of sixty houses built for competition.

The Judges upon awarding the premiums were able to report a distinct improvement in the planning of the houses generally, as compared with the previous exhibition, and that the attempts made to provide suitable dwellings at a reasonable cost were in many cases successful.

Roads' Improvement Association.—Mr. H. T. Wakelam: Since the important Conference was held in June, 1907, at the Olympia Exhibition, and at the Institution of Civil Engineers, the question of obtaining subsidies from the Imperial funds has been fully discussed, and the President of the Local Government Board has been approached with a view to his receiving a deputation on the subject.

Your Association have also forwarded a memorial to the Board praying that the matter should have the careful attention of the department, with a view to annual grants being made to the various road authorities, for the express purpose of road improvement.

It is hoped that the representations which are being made in this direction will bear fruit, and result in some scheme being formulated by the Board to bring about the object your Association, and other advocating bodies in this connection, have before them. Your President and myself are watching carefully the interests of the Association in the matter.

The National Registration of Plumbers.—Mr. T. W. A. Hayward: During the year six meetings of the Committee have been held, and six meetings of the General Purposes and Finance Sub-Committee, making twelve meetings in all.

Two examinations for Registration have been held, at which fifty-three candidates presented themselves, twenty passing the full technical and practical examination. The examinations were conducted by four examiners (two master plumbers and two operative plumbers), who are appointed by the Registration Committee. Examinations are held in the workshops at King's College by the permission of the Worshipful Company of Plumbers.

A very important development in the history of the Registration Movement has taken place during the year as the result of a conference between the Worshipful Company of Plumbers and representatives of the Registration Committee and the District Councils throughout the country, at which a scheme for the future management of the Registration Movement was adopted.

The scheme sets up a General Council composed of representatives of the Company, the Registration Committee and District Councils, as well as the chief plumbers' associations and public and professional bodies, concerned in the specification and regulation of plumbers' work. It is hoped that this development will heartily commend itself to all who are desirous of maintaining the high standard of qualification, and the status of the plumbing trade.

A large number of Metropolitan Borough Councils as well as many other Councils have decided that all plumbers' work should be carried out by registered plumbers. If this system is universally adopted, it is believed that it will result in best plumbers' work being done.

As a large amount of plumbers' work comes under the supervision of municipal surveyors, your representative has had great pleasure in attending the various meetings and helping

in what he considers to be this forward movement in regard to the registration of plumbers.

MEMORIALS.

In accordance with the resolutions of the last Annual Meeting, memorials upon the subjects of State Aid for Road Maintenance and Town Planning have been duly addressed to and acknowledged by the President of the Local Government Board.

Your Council have further addressed a memorial to the Prime Minister, urging that in view of the importance now attaching to the work of the Local Government Board, the status of the President of that Board should be raised to that of a Secretary of State.

Your Council have seized the opportunity presenting itself, in the clauses of the Town Planning Bill now before Parliament, to urge upon the Government the necessity of providing that the municipal engineer—upon whom the duties of carrying out the provisions of the Bill will chiefly fall—should be appointed and dismissed only by sanction of the Local Government Board.

DEPRECIATION OF ASSETS FOR INCOME TAX PURPOSES.

At the request of the Institution of Municipal Treasurers and Accountants, your Council appointed a committee to meet their Sub-Committee dealing with this matter. The question of the depreciation of tramway permanent way and paving was carefully gone into, and finally equated periods were suggested for adoption, and are now under the consideration of the Inland Revenue Authorities.

LEGAL PROTECTION TO MEMBERS.

Several cases have during the year been carefully investigated.

In one case it was found necessary and desirable to assist the member by legal advice, and strenuous efforts were made by the committee having charge of the case. A deputation attended at a meeting of the Authority, and laid the views

of the Association before them. The Council are gratified to report that in the result more favourable terms were obtained by the member.

Period of Loans sanctioned for Reinforced Concrete.

Your Council have appointed an influential deputation to wait upon the President of the Local Government Board in order to discuss certain difficulties arising from the restricted period of loans granted for work carried out in this material. It is confidently hoped that when the pressure of work in Parliament has somewhat slackened, the Right Hon. Mr. Burns will consent to receive the deputation and to hear their views.

Identification Badges.

These badges having met with universal approval at the last Annual Meeting, the Council have decided to continue their issue. The list of names has been somewhat altered with a view to ensuring greater convenience in its reference.

Bills in Parliament.

The Parliamentary Committee have had the following Bills under consideration:—

Public Health Act (1875) Amendment (Water Rights) Bill.
Public Health Officers Bill.
Housing of the Working Classes Bill.
Housing of the Working Classes Acts Amendment Bill.
Housing, Town Planning, etc., Bill.

and are still watching their progress.

Change of Title.

The Council have given careful consideration to the desirability of a change in the name of the Association, and propose to ask the members to agree to the alteration of the name to "The Institution of Municipal and County Engineers." The Council further propose that Bye-law 22 should be repealed and a new Bye-law substituted, sanctioning the use of descriptive abbreviations of title as printed for each class of membership.

Alteration in Memorandum.

In accordance with the requirements of the Board of Trade in sanctioning the Memorandum of the Association, a note has hitherto been appended to the testamur granted by the Association to the effect that the possession of the testamur "shows the result of an examination held on behalf of the Association, and is not to be deemed a qualification to discharge the duties of any position or appointment." It is obvious that such a proviso may be misleading to members of Local Authorities who may be unaware of the extreme care exercised by the examiners and the searching nature of the examination held by your Association, and the Council therefore propose to use their best endeavours to obtain the permission of the Board of Trade for the removal of a note which is both meaningless and unnecessary.

Information on Technical Subjects.

The Council desire to call attention to the practice of officials (other than Engineers or Surveyors), of Local Authorities, asking for information on technical subjects which properly come under the control of the Engineers and Surveyors. The Council desire to record their opinion that such information should be applied for, and given by, the Engineers and Surveyors only.

General.

Your Council desire to call the attention of members to the desirability of their advising the Secretary of the Association as to any forthcoming appointment of Engineers and Surveyors, or professional assistants to the same, with the object of enabling a letter to be sent to the Local Authority concerned in each case, directing attention to the value to be attached to membership of the Association, or to the possession of the testamur of the Association as an indication of the candidate's special education and training for such an appointment. Further, members of the Association are requested to give preference—other things being equal—to holders of the testamur in making appointments.

On the motion of the Chairman, seconded by Mr. H. G. Whyatt, the Report was received and adopted.

Dr. STATEMENT OF RECEIPTS AND EXPENDITURE

RECEIPTS.	£ s. d.	£ s. d.
To Balance, May 1, 1907	53 5 2	
„ Subscriptions in advance	61 11 0	
„ Arrears	124 4 0	
		239 0 2
„ Entrance Fees	29 15 0	
„ Subscriptions..	970 5 9	
„ Sale of "Proceedings"	32 14 5	
„ Examination Fees	248 17 0	
„ Interest on Investments	41 15 7	
„ Repayment of Loan and Interest	20 4 0	
„ Balance of Petty Cash, May 1, 1907	3 8 3	
„ „ due to Secretary, April 30, 1908	2 14 2	
		1349 14 2
	£	1588 14 4

Dr. NET REVENUE

	£ s. d.	£ s. d.
To Receipts as per statement	..	1349 14 2
„ Subscriptions, 1907–8, unpaid	152 15 6	
„ „ less 25 % bad	38 3 10	
		114 11 8
„ "Proceedings" (Vol. 34)	..	45 10 0
„ Balance being excess of expenditure over income for year ending April 30, 1908	..	163 9 3
	£	1673 5 1

Dr. STATEMENT OF ASSETS

LIABILITIES.	£ s. d.	£ s. d.
To Sundry Creditors	110 0 0	
„ Balance of Petty Cash due to Secretary	2 14 2	
		112 14 2
„ Subscriptions in advance	..	61 11 0
„ Balance being excess of assets over liabilities ..	..	1238 16 6
	£	1413 1 8

Examined with the vouchers and

EXPENDITURE.	£ s. d.	£ s. d.
By Reports of Meetings	..	63 0 0
„ Examiners' Fees and Expenses	..	188 3 7
„ Printing, Lithography, and Stationery	..	543 0 3
„ Meetings' Expenses	..	71 3 8
„ Rent of Office and Coals	..	79 4 9
„ Bankers' Charges	..	3 5 11
„ Telegraphic Address and Telephone	..	10 11 0
„ Delegates', Auditors', etc., Expenses	..	30 8 4
„ Premiums	..	13 0 0
„ Law Reports and Parliamentary Papers	..	8 18 0
„ Salaries	..	475 0 0
„ Petty Cash—		
Postages	33 7 1	
General	27 15 4	
		61 2 5
„ Office Expenses	..	13 13 0
„ Balance	..	28 3 5
	£	1588 14 4

ACCOUNT. Cr.

	£ s. d.
By Expenditure as per statement (less balance)	1560 10 11
„ Sundry creditors, April 30, 1908	112 14 2
	1673 5 1

AND LIABILITIES. Cr.

ASSETS.	£ s. d.	£ s. d.
By Balance at Bank, May, 1908	..	28 3 5
„ £290 Southampton Corporation 3½ % Stock at 102 ..	..	294 0 0
„ £553 12s. 9d. India 2½ % Stock at 78	..	431 0 0
„ £261 14s. 7d. London County Council 2½ % Consols at 78	..	203 10 0
„ £200 Metropolitan 2½ % Consolidated Stock at 80	..	160 0 0
„ Subscriptions in Arrear	192 17 6	
Less 50 % bad	96 8 9	
		96 8 9
„ "Proceedings" in Stock	238 15 0	
Less 50 %	119 7 6	
		119 7 6
„ Office Furniture	..	80 12 0
	£	1413 1 8

found correct, *May* 8, 1908.

SIDNEY STALLARD } *Auditors.*
R. A. MACBRAIR }

LEWIS ANGELL, *Hon. Treasurer.*
CHARLES JONES, *Hon. Secretary.*
THOMAS COLE, *Secretary.*

ALTERATIONS IN THE BYE-LAWS.

The Chairman then moved the following alterations in the Bye-laws:—

That the words "the Association" and "the Incorporated Association" be deleted wherever they occur in the bye-laws, and the words "the Institution" be substituted in lieu thereof.

Bye-law 14. To be altered by the addition of the words printed in italics.

Bye-law 14. . . . "Each Member receiving a Ballot Paper shall be entitled to vote for or erase any of the names thereon and to substitute others, subject in all cases to the limits of Clause 25 in the Articles of Association": *provided always that not less than fifteen names for Ordinary Members of Council be returned*. . . .

Bye-law 22. To be rescinded, and the following new Bye-law inserted in lieu thereof:—

Bye-law 22. The following abbreviations of the name of the Institution may be used to denote connection therewith:—

Members	M. Inst. M. & Co. E.
Associate Members . . .	Assoc. M. Inst. M. & Co. E.
Associates	Assoc. Inst. M. & Co. E.
Graduates	Grad. Inst. M. & Co. E.

The motions were duly seconded, and after discussion were put to the meeting and carried.

ALTERATIONS TO MEMORANDUM AND ARTICLES.

At a Special General Meeting held during the Thirty-fifth Annual Meeting, the following alterations to the Memorandum and Articles of Association were proposed by the Chairman (Mr. J. Patten Barber), duly seconded, and after discussion, carried:—

That the name of the Association be altered to "The Institution of Municipal and County Engineers."

ALTERATIONS IN THE MEMORANDUM OF ASSOCIATION.

That the words "Incorporated Association" be deleted wherever they occur in the Memorandum, and the word "Institution" be substituted in lieu thereof.

That Clause (*d*) of the Memorandum be altered by the deletion of the words printed in italics as follows:—

(*d*) The examination of persons in engineering, surveying, building construction, sanitary science and works, and in local government, municipal and sanitary law; and the granting of certificates of having passed the examination in the above subjects to candidates. *Provided that no such certificate be granted without a note on it stating that "This Certificate shows the result of an Examination held on behalf of the Association, and is not to be deemed a qualification to discharge the duties of any office or appointment."*

ALTERATIONS IN THE ARTICLES OF ASSOCIATION.

(Introduction, Clause 1)

That the words (hereinafter called "the Association") be altered to read (hereinafter called "the Institution").

(Introduction, Clause 2)

That the words "and whereas the Association" be altered to read "and whereas the Institution," and the words "by a registered Association" be altered to read "by a registered Institution."

That the words "the Association" be deleted wherever they occur in the Articles, and the words "the Institution" be substituted in lieu thereof.

Clause 25. To be altered by the addition of words printed in italics:—

COUNCIL.

25. The affairs of the Association shall be governed by a Council who shall be chosen from the Members only, and shall consist of one President, three Vice-Presidents, fifteen Ordinary Members of Council, Honorary Secretary, Honorary Treasurer, six Past-Presidents, and the District Honorary Secretaries for the time being.

The Council shall further co-opt, as Ordinary Members of Council, one Member to represent Scotland, and one Member to represent Ireland, should no such member or members be elected by the Annual Ballot for the election of the Council.

Clause 26. To be altered by the addition of words printed in italics.

26. The President, Vice-Presidents, Ordinary Members of the Council, *co-opted Members of Council,* and one Past-President who is an elective Member of Council, shall retire at each Annual General Meeting, but shall be eligible for re-election.

In accordance with the Companies Acts the change of title and the alterations to the Memorandum and Articles of Association were confirmed at a Special General Meeting, duly convened and held in the Congress Hall, Franco-British Exhibition, July 18, 1908.

Mr. Barber presented the Association Premiums for papers read at meetings during the previous year, awarded by the Council as follows:—

5*l.* in books to Mr. E. E. W. Butt (graduate) for his paper entitled "Calculation of Storm Water Discharge and Design of Sewerage Details."

3*l.* in books to Mr. J. W. Leebody (member) for his paper entitled "County Road Maintenance in Ulster."

3*l.* in books to Mr. T. Aitken (member) for his paper entitled "Maintenance of Roads."

Mr. R. A. MacBrair was elected Hon. Secretary for the Eastern District, Mr. T. W. Stainthorpe was elected Hon. Secretary for the African District, and the other Hon. District Secretaries were re-elected pending meetings in their respective districts.

Mr. S. Stallard and Mr. G. W. Lacey were elected Auditors for the ensuing year.

Messrs. R. J. Angel, A. H. Campbell, F. Harris, T. Henry, H. B. Purser, H. Shaw, C. C. Smith, and O. E. Winter, were elected Scrutineers for the ensuing year.

Mr. Barber then introduced Mr. Brodie's successor in the Presidential Chair—Mr. E. Purnell Hooley.

A hearty vote of thanks was accorded by acclamation to the retiring President for his services to the Association during his year of office.

APPENDIX.

STATISTICAL RETURNS

On the following subjects lie at the Offices of the Association, 11 Victoria Street, Westminster, S.W. Those marked thus * are in duplicate, and can be borrowed for perusal by Members on application to the Secretary. Those *not* marked * can only be inspected at the Offices.

N.B.—Please quote Reference Number when applying for Loan of Returns.

(Members are requested, when kindly sending statistics, to do so in duplicate if possible.)

Ref. No.	
	Abattoirs (Public).
12	W. Chapple Eddowes. 1902.
	Cemeteries (Public).
53	*H. Richardson. 1904.
	Drainage Connections (Private).
11	*H. Richardson. 1902.
	Drainage (House).
1	J. Atkinson. 1894.
	Drainage (New Buildings).
49	*E. J. Lovegrove. 1896.
	Fire Brigades.
36	G. T. Lynam. 1899.
67	*H. W. Longdin. 1907.
	Hospital (Infectious Diseases).
59	*J. Walker Smith. 1905.
	Labour, Conditions of.
63	*A. E. Collins. 1906.
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3	J. W. Brown. 1894.
4	J. W. Cockrill. 1891.

Ref. No.	
	LIGHTING (ELECTRIC).
5	W. A. Davies. 1893.
40	E. J. Silcock. 1896.
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6	J. W. Bradley. 1895.
7	P. Ross. 1896.
	LIGHTING (PUBLIC STREET).
9	C. C. Smith. 1892.
8	A. H. Campbell. 1895.
48	*E. J. Lovegrove. 1900.
54	*A. E. Nichols. 1903.
68	*C. Chambers Smith. 1908.
70	F. C. Cook. 1907.
	LIGHTING (PUBLIC STREET) (TIMES OF).
69	G. W. Warr. 1908.
	LIQUID NIGHT SOIL (DISPOSAL OF).
38	*G. T. Lynam. 1899.
	MOTOR WAGONS (UTILITY AND WORKING OF).
57	*J. Walker Smith. 1905.
58	*R. J. Angel. 1903.
	PAVEMENTS (COMPARISON OF LIFE AND COST OF GRANITE AND GRITSTONE).
10	C. F. Wike. 1890.
	PAVEMENTS (TAR MACADAM).
46	A. E. Collins. 1896.
47	J. Hall. 1896.
41	E. A. Stickland. 1897.
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13	W. J. Newton. 1892.
56	*T. J. Rushbrooke. 1905.
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42	*P. Edinger. 1897.
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14	J. Price. 1891.
2	*A. E. Nichols. 1906.
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15	W. Brooke. 1885.
33	J. Gammage. 1899.
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16	J. Price. 1896.
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17	C. R. Fortune. 1886.
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18	W. Howard-Smith. 1894.
	ROADS (PAVING OF MAIN).
31	H. Richardson. 1899.
	ROADS (STEAM ROLLING OF).
19	A. W. Parry. 1885.
	ROADS (WATERING OF).
20	W. Dawson. 1891.
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66	*J. S. Pickering. 1905.
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21	J. H. Cox. 1892.
22	H. Richardson. 1890.
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23	J. T. Earnshaw. 1893.
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50	*T. R. Smith. 1902.
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26	J. E. Swindlehurst. 1891.
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24	*G. T. Lynam. 1903.
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27	E. Pritchard. 1895.
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29	*J. W. Cockrill. 1897.
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Surveyor and Municipal and County Engineer.

EXAMINATIONS.

SYLLABUS.

The Incorporated Association of Municipal and County Engineers undertake the holding of Examinations, by written papers and *vivâ voce*, in the following subjects:—

Engineering as applied to Municipal work. (Two papers.)
Building Construction and Materials.
Sanitary Science as applied to Towns and Buildings.
Municipal and Local Government Law as relating to the work of Municipal Engineers and Surveyors.

Every candidate who applies for permission to sit for the Examination of the Association must be at least 22 years of age, and must possess one of the Certificates hereinafter mentioned in each of the following subjects:—

English, including (1) English Composition; (2) English Grammar, including Analysis and Parsing; (3) English History; (4) Geography.

Mathematics, including (1) *Arithmetic*—Vulgar and decimal fractions, proportion, square root, simple and compound interest, profit and loss, percentage, H.C.F. and L.C.M.; (2) *Algebra*—the ordinary rules; fractions; brackets; simple, simultaneous and easy quadratic equations, and problems involving the use of such equations; H.C.F.; L.C.M.; and square root; (3) *Euclid*—the first three books.

List of Certificates which will be accepted as evidence that Candidates possess the necessary qualifications in the various subjects:—

(1) English Composition and (2) English Grammar.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "English Composition," "English Language," and "English Literature."

Oxford Local: Senior Examination—Honours or Pass. Junior Examination—Honours or Pass. *Cambridge Local*: Senior Examination—Honours or Pass. Junior Examination—Honours or Pass.	Certificate for English Language and Literature will be accepted as qualification required in English Composition and English Grammar.

Society of Arts: Advanced stage—First or Second Class, obtained since 1904; Intermediate stage—First Class, obtained since 1904; and the certificates corresponding thereto obtained prior to 1904.

College of Preceptors: First Class (or Senior), Second Class (or Junior), in the Professional Preliminary Examination; First Class (or Senior), Second Class (or Junior), in Certificate Examination.

(3) English History.

University of London: Matriculation Examination.

Victoria University: Preliminary Examination.

University of St. Andrews: Preliminary Examination in Science.

University of Glasgow: Preliminary Examination in Science.

University of Aberdeen: Preliminary Examination in Science.

University of Edinburgh: Preliminary Examination in Science.

University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior.
Oxford Local: As for English Composition and English Grammar. Certificate for History will be accepted as qualification required in English History.
Cambridge Local: As for English Composition and English Grammar. Certificate (Senior or Junior) for History, Geography, etc., will be accepted as qualification required in English History and Geography.
Society of Arts: As for English Composition and English Grammar. Certificate for Commercial History and Geography will be accepted as qualification required in English History and Geography.
College of Preceptors: As for English Composition and English Grammar.

(4) Geography.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior.
Oxford Local: As for English Composition and English Grammar.
Cambridge Local: As for English History.
Society of Arts: As for English History.
College of Preceptors: As for English Composition and English Grammar.

Mathematics.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."
Oxford Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."
Cambridge Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."
College of Preceptors: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."
Board of Education: Science Examination—Stage 1, First Class; or Stages 2 and 3, any Class.

The foregoing regulations do not apply to Candidates who have previously sat or received permission to sit.

A Candidate who has been awarded any of the undermentioned Certificates is exempt from further educational examination: The Institution of Civil Engineers, Studentship; The Royal Institute of British Architects, Preliminary; the Surveyors' Institution, Preliminary.

The Council reserve power to alter or add to the foregoing requirements.

Two or more Examinations are held in each year, one at least, in April, in London, and one at least, in October, in some provincial town to be fixed on by the Council and duly advertised beforehand.

Examinations will also be held in Scotland and Ireland, providing a sufficient number of Candidates desire to enter. Examinations in Scotland will be held in October; in Ireland, in April.

The Council will consider applications, which must be made on the form issued with the syllabus.

If permission is granted by the Council, a "sitting" form will be forwarded. The candidate may then make application on such form to be entered for the next ensuing, or any future, examination.

Candidates who have sat and failed, are particularly requested

to ask for a "sitting" form, when they desire to enter their names for re-examination.

The Council will accept entries, in order of priority, as far as accommodation will permit.

The fee for each Examination is 4*l.* 4*s.*, two guineas to be paid with the "sitting" form, and two guineas on the day of examination.

The fee is to be sent with the sitting form ONLY.

Candidates who do not present themselves for examination forfeit their entrance fee.

A candidate sitting for examination *after* October 1907, and failing to satisfy the examiners in *not more than two* of the five subjects, will be permitted to sit at any subsequent examination, on payment of half-fees, for re-examination only in the subject or subjects in which he failed. Upon completing his passes in all the five subjects, he will be duly granted the testamur of the Association.

A candidate failing in *more* than two subjects will be permitted to sit, for re-examination in all the subjects, at any subsequent examination, on payment of half-fees.

The Examinations occupy three days, and the subjects are taken as follows:—

First day,	10 to 1 ..	..	Sanitary Science.
„	2.30 to 6.30	..	Building Construction.
Second day,	10 to 1 ..	..	Engineering (1st Paper).
„	2.30 to 6	..	„ (2nd „).
Third day,	9.30 to 11.30	..	Municipal and Local Government Law.
„	12	..	*Vivâ voce* Examination.

Candidates must attempt one question in each section, but must not attempt more than six questions in each subject. In the case of Municipal Law, which is not divided into sections, not more than six questions must be attempted.

Successful candidates receive a Certificate in the form of a "Testamur," signed by the acting Examiners, and sealed and countersigned by the President and Secretary of the Association in Council.

No information as to the result of an Examination, beyond the fact of a candidate having "Passed" or "Failed," is given.

Questions set at Examinations held prior to 1902 can only be obtained in the volumes of the 'Proceedings.' On sale by Messrs. E. & F. N. SPON, Ltd., Publishers, 57 Haymarket, S.W. The questions set at subsequent examinations are not published.

Any inquiries referring to the Examinations should be directed to Mr. THOMAS COLE, Secretary to the Association, 11 Victoria Street, London, S.W., and should be accompanied by an addressed foolscap envelope.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work: 1st Paper:

A. Sewage Disposal.
B. Tramways Construction.
C. Bridge Construction.
D. Water Supply.

II.—Engineering as applied to Municipal Work: 2nd Paper:

A. Geodesy.
B. Hydraulics.
C. Sewerage.
D. Road Construction and Maintenance.

III.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building By-laws.
D. Public Baths and Hospitals.

IV.—Sanitary Science as applied to Towns and Buildings:

A. Heating and Ventilation.
B. Scavenging and Disposal of Refuse.
C. Water Supply and Drainage of Buildings.
D. Disinfection.

V.—Municipal and Local Government Law as relating to the Work of Municipal Engineers and Surveyors.

Note.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his acquaintance with any particular book or books.

EXAMPLES OF QUESTIONS.

The following questions have been compiled from Examination Papers set to Candidates, and serve as examples of the questions asked under the different sections.

DIRECTIONS.—"You are particularly requested to write legibly, and to answer the questions as concisely as possible. *Fill in your number where indicated, also at the top of every book handed in. Prefix the number of the question to each answer. Place this question-paper inside your book before handing it in.* Wherever possible, freehand sketches or diagrams should be drawn to illustrate the answer; these should be carefully executed, as they will be taken as showing the Candidate's proficiency in this style of drawing. Candidates must not, during the examination, refer to any books or manuscript, or communicate with each other. Slide rules may not be used."

I. SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

(Candidates must attempt one question in each section, but not more than six in all.)

FIRST PAPER.

(*Time allowed, 3 hours.*)

SECTION A. SEWAGE DISPOSAL.

1. Describe briefly the various systems of treatment now in use at outfall works; explain their general principles, advantages, and disadvantages.
2. Describe an up-to-date system of sewage disposal suitable for a district of 10,000 population, taking a dry-weather flow of 40 gallons per head per day, and state how you would deal with storm water. Give dimensions wherever possible.
3. A series of settling tanks are to be constructed, each to contain 250,000 gallons. State the dimensions you suggest for one of such tanks, and give sketch, plan and sections showing the form of bottom you suggest, and the position of inlets and outlets, and how same should be formed.

SECTION B. TRAMWAYS CONSTRUCTION.

4. Sketch and describe the various kinds of tramway rail joints in use for electric traction, stating their respective advantages and disadvantages. Design an ordinary fish-plate joint, and point out the features to which you consider special attention should be paid.

5. Sketch the cross-section of a road 32 ft. wide between kerbs, one side being 1 ft. lower than the other, with double track tramway, 3 ft. 6 in. gauge; show, in figures, the "cambering" of the road, when paved the whole width with stone setts, or Jarrah wood, and also when the tramway is paved with setts, and the remainder of the road macadam.

6. Sketch a "turn out" or "passing place" on a single line of tramway, figure the leading dimensions, the angle of the crossings, and describe the length, position and character of the "points" required for diverting the traffic.

Section C. BRIDGE CONSTRUCTION.

7. Work out the strains on a wrought-iron girder (sketch given) 56 ft. span, 7 ft. high, and give figured sections of flanges, struts and ties. Distributed load 200 tons.

8. State the live load per foot run of paths and carriageway you would allow for in the case of a bridge, 60-ft. span, with a carriageway 36 ft. wide, and 12-ft. paths on each side.

   The bridge has two lines of tramway, 4 ft. 8½ in. gauge, to carry cars weighing 5 tons when loaded, the distance between the two wheel axles being 18 ft.

9. A bridge has to be constructed to carry a 60-ft. street over a canal, the clear span being 40 ft., the minimum head room being 11 ft. at centre and 9 ft. at sides above normal water-level: the approaches are rising gradients of 1 in 24 and 1 in 90 respectively. Sketch the bridge you recommend for such a position, giving all important particulars, short specification tests for materials, and tests for bridge when completed.

Section D. WATER SUPPLY.

10. What percentage of total annual rainfall over a watershed would you expect to have available for storage? State locality and characteristics of the watershed to which your answer relates.

11. A covered reservoir is required to serve a town of 5000 inhabitants. Sketch and describe the reservoir you would adopt, giving all requisite details, and assuming your own conditions of site and foundation. Give a short specification of the necessary works, tests for materials, and an estimate of cost.

12. Sketch and describe a small pumping station capable of lifting daily 100,000 gallons of water from a borehole in the rock and delivering through a rising main 500 yards long into a reservoir, the total vertical lift being 100 ft. After working out the theoretical horse-power required, state the brake horse-power and type of engine you recommend, and give your reasons.

II. Subject:—ENGINEERING as applied to Municipal Work.

(Candidates must attempt one question in each section, but not more than six in all.)

SECOND PAPER.

(Time allowed, 3½ hours.)

Section A. GEODESY.

1. Describe the mode of making a land survey with the chain only, and with the usual instruments, and explain the advantages of the latter method. Describe the instruments, and give an illustration of a "field-book" with imaginary entries therein.

2. Make a sketch of the primary and vernier scales of a theodolite for reading to minutes. Explain the object of the vernier, and the principle upon which it works.

3. How would you proceed to contour and make a plan of a valley proposed to be used as an impounding reservoir? What is the advantage of a contour plan for this purpose?

Section B. HYDRAULICS.

4. The velocity in a 9-in. pipe, running full, laid at a gradient of 1 in 48, is 352 ft. per minute. Give the velocities in such a pipe when laid at the following gradients: 1 in 16, 1 in 96, and 1 in 432.

5. A pumping main a mile in length is required to discharge 600 gallons per minute at a velocity of 3 ft. per second. What diameter pipe is necessary?

6. What do you mean by "hydraulic mean depth"? Why is the hydraulic mean depth the same in the case of a circular pipe flowing full or half full, supposing you agree that it is so?

Section C. SEWERAGE.

7. Describe the usual method of setting out the lines for the construction of a sewer, and the means that should be adopted to ensure that the invert shall be laid to the correct depth and gradient.

8. Make a detail sketch with figured dimensions of a storm overflow chamber on a 3 ft. by 2 ft. egg-shaped sewer, discharging when full 600 cubic ft. per minute, assuming that the storm overflow will come into operation when the sewage flowing is one-third the depth of the sewer.

9. A circular sewer, 4 ft. internal diameter, is to be constructed with brickwork in open cutting, the invert being 15 ft. below the surface of the ground. Trial holes show 6 ft. of loose made ground, 4 ft. of clay, and 12 ft. of running sand resting on a thick bed of clay. Show by sketches the timbering of the trench and the construction of the sewer, and give a description of the work and materials.

Section D. ROAD CONSTRUCTION AND MAINTENANCE.

10. Do you consider the stones in macadam should be all of one gauge, or do you prefer varying sizes? State the reasons for your preference.

11. A macadamised carriageway 36 ft. wide has got into bad repair, and the whole surface requires to be recoated with stone for an average thickness of 3 in. Explain in detail the different operations necessary to carry out the repairs, including rolling, and give the cost per yard of each operation, assuming that the cost of the stone delivered on the road is 12*s*. 6*d*. per ton, binding material 3*s*. 6*d*. per ton, and labour 5*d*. per hour.

12. Give a brief description and express your opinion of any methods of road construction and treatment with which you are familiar for the prevention of dust caused by motor traffic.

III. Subject:—BUILDING CONSTRUCTION.

(Candidates must attempt one question in each section, but not more than six in all.)

(*Time allowed, 4 hours.*)

Section A. MATERIALS.

1. State what you know of the various timbers used in building, and what class of work and situation they are each adapted for.

2. State the crushing and safe working loads of any brickwork with which you are acquainted, describing the brickwork.

3. Explain, as far as you can, the different characteristics and chemical composition of common lime, hydraulic lime, Roman cement, Portland cement, and Keene's cement.

Section B. THE CONSTRUCTION OF PUBLIC AND PRIVATE BUILDINGS.

4. A girder, with a clear span of 30 ft., bears a uniformly distributed load of 40 tons; it is supported at one end by a wall and at the other by a hollow cast-iron column, circular in section. The column is 10 ft. in height with fixed ends. Give the dimensions of the column, with method of calculation.

5. In the construction of a factory chimney specify the following:—
   (a) The subsoil being a stiff clay and weight of shaft 1000 tons, what area of concrete is it necessary to provide for foundation?
   (b) What proportion should the spread of the footings bear to the thickness of the brickwork at the base of the shaft?
   (c) In a shaft 200 ft. high, give the varying thickness of brickwork from base to cap, with distances between the various offsets and height of fire-brick lining.
   (d) What is the usual proportion of the diameter of base to the height of shaft (circular on plan)?
   (e) State the comparative advantages of circular, octagonal and square shafts with regard to wind resistance.
6. Sketch a concrete beam reinforced with steel rods to carry a distributed dead load of 20 tons with a clear span of 15 ft. Show your calculations.

Section C. BUILDING BY-LAWS.

7. State how the subsoil of the site of an intended new building should be drained, "where the dampness of the site renders such precaution necessary." Give sketch-plan of drains.
8. Describe fully the chief provisions for the prevention of the spread of fire from one house to another.
9. What information must be given to a sanitary authority by a person desirous of laying out a new street?

Section D. PUBLIC BATHS AND HOSPITALS.

10. Make a cross-sectional sketch of a public swimming bath, 44 ft. in width over all, showing the bath, dressing-boxes, gallery, and roof, with their several dimensions. Describe fully the means adopted for rendering the bath water-tight, and give the type of roof.
11. In designing an isolation hospital for 100 beds, shortly describe the following provisions, viz.:—

    Number and extent of ward blocks.
    Nature of other buildings necessary for administration purposes.
    Proportion of floor space per bed.
    Proportion of cubical space per bed.
    Method of ventilation to be adopted in wards.
    Method of heating to be adopted in wards.
12. In designing public baths, comprising, say, a swimming bath 70 ft. × 30 ft., ten slipper baths, and a small laundry, what method would you adopt to heat the water, and how would you warm the building?

IV. Subject:—SANITARY SCIENCE as applied to Towns and Buildings.

(Candidates must attempt one question in each section, but not more than six in all.)

(*Time allowed*, 3 *hours*.)

Section A. HEATING AND VENTILATION.

1. Explain what you mean by "natural" and "artificial" ventilation. Illustrate your answer by sketches of each as applied to a public building or school. What are the advantages and disadvantages of each system?
2. In preparing a scheme for warming a building, what are the recognised methods of calculating the amount of heating surface required for varying temperatures?
3. Describe concisely three different methods of ventilating sewers, expressing your views as to their merits or otherwise.

Section B. SCAVENGING AND DISPOSAL OF REFUSE.

4. Describe the method you would adopt for collecting—
   (*a*) The contents of cesspools.
   (*b*) Excreta in pails.
   (*c*) Offal.

   And give particulars of the vehicle you would recommend in each case.
5. Describe the essential features of a good type of refuse destructor, and give a section of the same.
6. Describe the most satisfactory means of
   (*a*) Removing house refuse
   (*b*) Cleansing ashpits and privies

   where the local authority undertake the work of removal.

Section C. WATER SUPPLY AND DRAINAGE OF BUILDINGS.

7. Describe the construction of a hot-water service for bath and other purposes in a house. Describe how the circulation is obtained, and show, by a diagram, the position of the boiler, cistern, cylinder, etc., and state the precautions that should be taken to prevent damage by frost.
8. State shortly what are the general principles of efficient house drainage, and give a few examples of how these are frequently disregarded in actual practice.
9. What kind of water acts upon lead? State the risk attendant upon its use and the means you would adopt for avoiding or reducing such risk.

SECTION D. DISINFECTION.

10. Mention the various disinfectants in common use, and state which you consider the best for particular purposes. Describe the methods of use and the precautions necessary.

11. What are the points to be observed in the selection of the necessary apparatus to effect the proper disinfection of bedding and clothing? Give a brief description of the apparatus with which you are acquainted.

12. Describe how you would proceed to disinfect a house after the following diseases: (*a*) scarlet fever, (*b*) typhoid fever, (*c*) diphtheria, (*d*) small-pox.

V. SUBJECT:—MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL AND COUNTY ENGINEERS AND SURVEYORS.

(England)

(Candidates must not attempt more than six questions.)

(*Time allowed*, 2 *hours*.)

1. Under what Act can a local authority make bye-laws as to deposit of plans for alterations to existing buildings, and to what buildings do these bye-laws apply?

2. What are the conditions under which a manufacturer may discharge his trade refuse into the sewers of a local authority?

3. Can a local authority compel a proper supply of water to be laid on to premises, and if so, under what conditions in (*a*) urban districts, (*b*) rural districts? State the mode of procedure in each case.

4. The surveyor to a local authority has reported to him (*a*) a dangerous building abutting on a public highway, and (*b*) a dangerous chimney on private enclosed premises. State what are his powers and duties in each case, and set out fully the proceedings he would take in proper sequence.

5. An occupier refuses to allow his premises to be entered by the assistants of the surveyor to a local authority for the purpose of taking levels; what course is prescribed by statute to meet such a case?

6. State which Acts give powers respecting tramways and light railways, and describe the principal differences between them, particularly as to position of tramway in road, spaces, notices, supervision, and mode of procedure.

7. Describe the provisions of the Buildings in Streets Acts, 1888, and point out in what respect they differ from the previously existing powers.

8. What rights have owners and occupiers of property to connect their drainage with the sewers of a local authority (*a*) within the district, (*b*) without the district? (*c*) under what restrictions can the connections be made? and (*d*) what are the penalties for non-compliance?

9. Give two instances where you consider the present Public Health and Sanitary Acts or Highways Acts are defective or require amendment, and in what way would you remedy these defects?

   This question is intended to elicit answers from candidates as to any difficulties they may have experienced or observed or heard of in carrying out the duties of a surveyor.

10. What is a Provisional Order, and when is it usually applied for? Compare it with a local Act of Parliament, specifying its chief advantages. State the nature of Provisional Orders issued by the Board of Trade as distinct from the Local Government Board.

11. Give reasons for recommending a council to adopt the Private Streets Works Act, 1892. State also the disadvantages of that Act compared with sections 150 and 152 of the Public Health Act, 1875.

12. What powers have local authorities with respect to—

    (*a*) Planting of trees in highways?
    (*b*) Underground conveniences?
    (*c*) Sanitary conveniences for manufactories?
    (*d*) Ingress to and egress from places of public resort?
    (*e*) Safety of platforms on public occasions?

V. MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Scotland)

(Candidates must not attempt more than six questions.)

(*Time allowed, 2 hours.*)

1. Define the various roads to which these words apply, viz., Highway. Turnpike Road, Statute Labour Road, as interpreted by the Roads and Bridges (Scotland) Act, 1878.

2. Describe the statutory provisions whereby a local authority can recover from any person expenses for damage to highways caused by extraordinary traffic thereon, or by excessive weight passing along the same; and state in what Act of Parliament these provisions are embraced.

3. To whom must application be made for authority to lay out new streets? Specify the details which require to be shown on the plan accompanying the application.

4. If a Burgh should desire to improve any existing private streets, what statutory procedure would be necessary?

5. What are the powers of a Burgh with reference to the keeping of footpaths of public streets in proper repair? How far do these powers apply to private streets?

6. Specify the procedure which must be adopted in a Police Burgh before a public sewer can be laid. Under what Act is this necessary?
7. What powers of entry are given under the Public Health (Scotland) Act for the purpose of examining drains, and what is the necessary procedure?
8. Specify the duty of a Local Authority with reference to the water supply of buildings in an isolated district.
9. Enumerate the powers given for the formation of special water supply districts. State briefly under what circumstances a Local Authority is bound to take action.
10. What were the requirements of the 1892 Burgh Police (Scotland) Act with regard to back space for proposed buildings, and what alteration was made by the 1903 Act?

BOARD OF EXAMINERS.

The President of the Association (*ex-officio*).

Lewis Angell, M. Inst. C.E., F.R.I.B.A., Fellow of King's College, London,
J. P. Barber, M. Inst. C.E.
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CANDIDATES WHO PASSED THE EXAMINATIONS HELD 1907–1908.

59th and 60th Examinations, October 1907.

A. E. W. Aldridge.
S. E. Axon.
W. A. Bott.
J. S. Bullough.
T. A. Clare.
G. R. Collinson.
D. Furness.
H. N. Hedges.
P. Holt.
R. O. Jones.
F. W. Knight.
T. K. Roddan.
C. C. V. Roebuck.
E. Taylor.
C. H. Waithman.
W. H. W. Walden.

61st and 62nd Examinations, April 1908.

S. C. Baggott.
L. D. Brothers.
H. B. E. Brown.
H. J. Chapman.
J. A. Charles.
B. Cooper.
J. Cunliffe.
R. Fletcher.
E. F. Harmer.
W. B. Madin.
W. T. Minshull.
R. C. Moon.
J. B. Panks.
J. W. Pooley.
L. G. Roberts.
J. W. Trodd.

Memoirs of Deceased Members.

THE Council, having been requested to append some short notice of the decease of Members of the Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these "Proceedings."

Mr. JOHN POLLARD died on September 3, 1907, in the 55th year of his age. For some years he was engaged under the late Sir Joseph Bazalyette, upon the Thames Embankment and other works constructed for the Metropolitan Board of Works. He was Surveyor to the Hendon Local Board from 1880 to 1887, and designed a system of Main Sewerage and Sewage Disposal for the district. In 1887 he, in partnership with Mr. H. J. Tingle, M.Inst.C.E., commenced private practice in Westminster, and remained a partner in this firm to the time of his death.

Mr. Pollard was a Member of the Institution of Civil Engineers, and was elected a Member of this Association in March, 1884.

Mr. WILLIAM STRINGFELLOW, late Surveyor to the Thame Urban District Council (Oxfordshire), disappeared from the steamer *Alberta* during the voyage from Southampton to the Channel Islands on September 3, 1907, in the 40th year of his age. He was appointed in the previous May to Thame, previous to which he was Surveyor to the Urban District Council of Ashborne, Derbyshire.

Mr. Stringfellow was an Associate Member of the Institution of Civil Engineers and was elected a Member of the Association in June, 1893.

Mr. HUGH NETTLETON, late Surveyor to the Urban District Council, Weston-super-Mare, died very suddenly from heart disease on October 20, 1907. He filled the position of Surveyor at Weston-super-Mare for over sixteen years, and he carried out several important drainage works, the widening of the sea front at Anchor Head, and improvements on the parade and in the parks.

Mr. Nettleton was an Associate Member of the Institution of Civil Engineers, and was elected a Member of the Association in July, 1893.

Mr. WILLIAM THWAITES, M.A., late Engineer in Chief Metropolitan Board of Works, Melbourne, died on November 19, 1907. In 1874, Mr. Thwaites was engaged on the Victorian and South Australian Railways. In 1879 he entered the Public Works Department of Victoria, and in 1891 he was appointed Engineer-in-Chief, Melbourne and Metropolitan Board of Works. During the tenure of his office he carried out the drainage of Melbourne and other very important works.

He was a Member of the Institution of Civil Engineers, and was elected a Member of the Association in April, 1898.

Mr. LEWIS STEVENS, late Surveyor to the Newton Abbot Urban District Council, died suddenly on January 2, 1908, in the 52nd year of his age. He succeeded his father as the Surveyor of the old Local Board, and during the twenty-seven years that he occupied the position carried out the Sewage Outfall Works, the laying out of Baker's Park, the construction of many roads, the reconstruction of the Cattle Market, and many other works of importance.

Mr. Stevens was elected a Member of the Association in March, 1890.

Mr. ROBERT FRANK VALLANCE, late Borough Surveyor of Mansfield, died on April 18, 1908, in the 51st year of his age. Mr. Vallance was appointed Surveyor in 1894 to the Mansfield Improvement Commissioners, and when the town was incorporated in 1891 he became Borough Surveyor. He was also Surveyor to the Warsop Urban District Council. He rendered valuable service to the Mansfield Hospital, of which he was the

honorary Architect for many years. As a Freemason, he was a P.M. of the Forest Lodge, and Treasurer of the Forest (Royal Arch) Chapter.

Mr. Vallance was elected a Member of the Association in September, 1889.

Mr. ROBERT COLLETT MAWSON, late Borough Surveyor of Evesham, died on April 20, 1908. Mr. Mawson went to Evesham over twenty-five years ago to take charge of the Waterworks. During the past quarter of a century he superintended the carrying out of many important undertakings in the town and district, including the enlargement of the Evesham reservoirs.

Mr. Mawson was elected a Member of the Association in March, 1892.

Mr. JOHN MALLINSON, late Engineer and Surveyor to the Skipton Urban District Council, died very suddenly from failure of the heart on May 1, 1908. He was a pupil to his father, who was Surveyor to the Skipton Council, and for a short time was Chief Assistant to the Borough Engineer of Batley. In 1898 he was appointed to Skipton, where he carried out many important schemes of public utility.

Mr. Mallinson was elected a Member of the Association in February, 1900.

Mr. ALFRED WELLER, late Borough Surveyor, Brighton, died on June 10, 1908, in the 60th year of his age, after a painful illness which had extended over eight weeks. Mr. Weller entered the Surveyor's Department in 1866, and was appointed Surveyor in 1905, in succession to the late Mr. May. Mr. Weller was also Surveyor to the Brighton Intercepting and Outfall Sewers Board. His long acquaintance with the measures of foreshore protection undertaken in Brighton brought him into prominence as a witness before the Royal Commission on Coast Erosion.

Mr. Weller was elected a Member of the Association in September, 1907.